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METALS and ALLOYS

The Engineering Magazine of the Metal-Working Industries

VOLUME 20 • NUMBER 6 • DECEMBER, 1944

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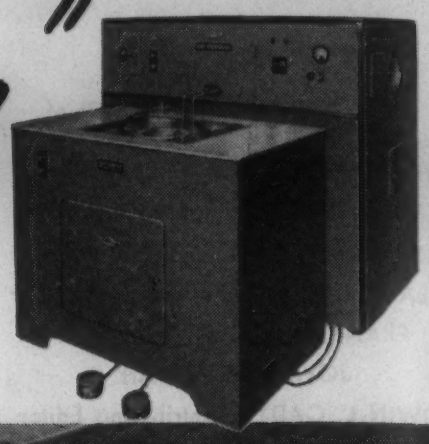
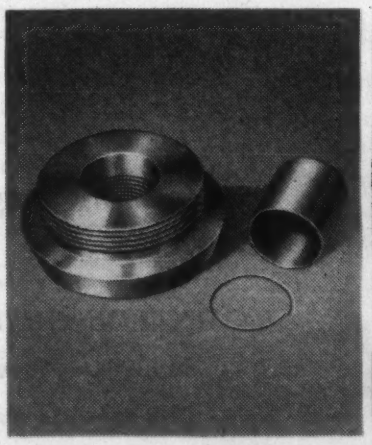
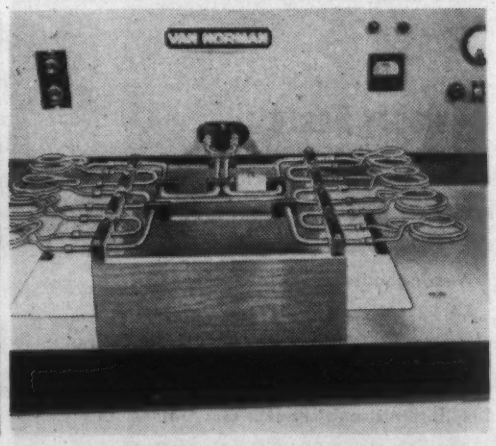
VAN NORMAN HIGH FREQUENCY

"Packaged Heating"



MULTIPLE BRAZING IN ONE OPERATION





Workpiece and multiple load coil arrangement used for the job illustrated above. While machine heats 4 parts in one side of load coils, the operator unloads and loads other set of load coils. The result speeded output and economy.

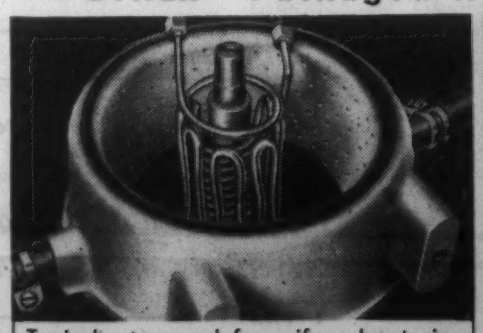
Typical of the versatility of the Van Norman "Packaged Heating" is the setup for multiple brazing of the part shown above. The operation consists of a cup brazed into the hub. Van Norman "Packaged Heating" does the job on four parts simultaneously in 25 seconds. The operator places four preassembled parts in one side of the load coil . . . starts the heat cycle and the machine does the rest . . . the result, perfect brazed joints free from scale or discoloration.

By simply changing the work load coil and fixture, Van Norman "Packaged Heating" is ready for use for practically any heating requirement.

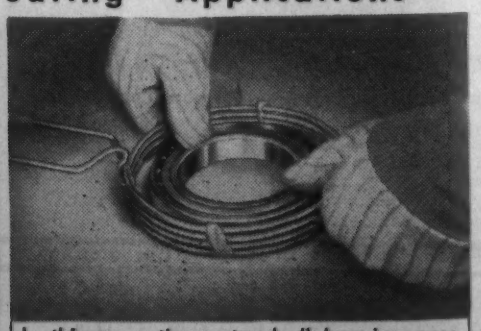
Another advantage of Van Norman high frequency "Packaged Heating" is that it gives manufacturers and commercial job shops a versatile heating unit for hardening, brazing, annealing, soldering, and forging. And the best part of Van Norman "Packaged Heating" is that it comes complete with all controls, meters and timing devices for automatic operation on every type of heating job.

Investigate Van Norman high frequency "Packaged Heating." Find out how it will speed up production, save time and cut costs. Let us prove to you how Van Norman "Packaged Heating" will pay for itself out of savings in a very short time.

OTHER "Packaged Heating" Applications



Typical setup used for uniform hardening teeth of a worm gear.

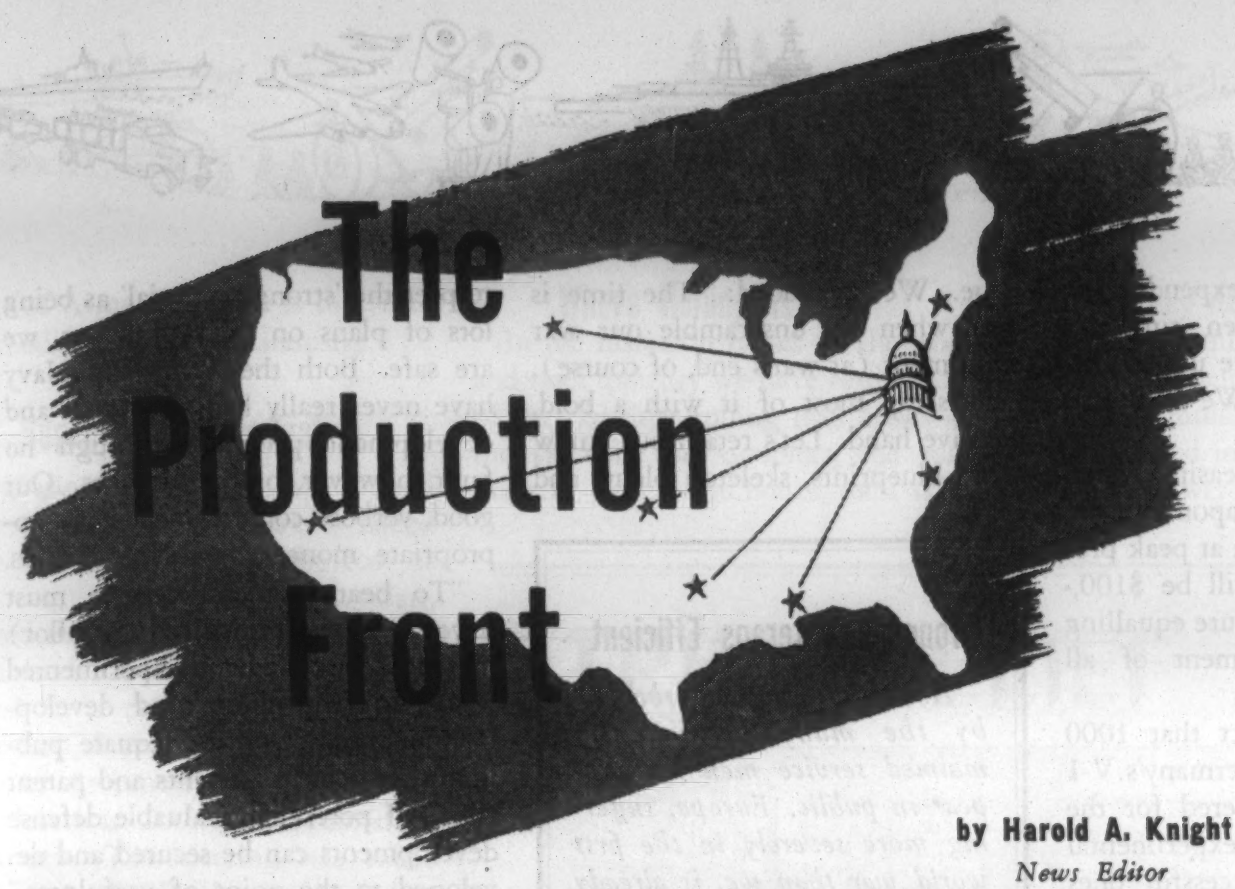


In this operation outer ball bearing race is expanded by heating so that balls can be easily fitted into place.

VAN NORMAN COMPANY

SPRINGFIELD 7, MASSACHUSETTS

"It Pays to Van Normanize"



by Harold A. Knight
News Editor

We ran out of ammunition "because we were successful." . . . We're months ahead of the timetable. . . . We're shipping shells while they're hot. . . . To meet munitions output schedule, we must produce 6% above past record. . . . Heavy artillery is best life insurance policy. . . . The Nazis are throwing 'em back bigger and faster.

Considerable agitation for armament research during peace. . . . "Military armament stands at threshold of unknown vistas." . . . Suggested that research be private—not Governmental. . . . "The record of weapon research until 1940 not a glorious one." . . . Records okay physically handicapped in plants. . . . Lack of standardization between U. S. and Britain added $100,000,000 to war cost. . . . Threads and truck parts are examples.

We are fascinated by muscular finesse at old-time rolling mill. . . . That hot rod passer a "natural" for Harlem night club. . . . Xmas spirit via cartoon. . . . Small plant owners get the breaks. . . . Metal that "pulsates" and makes you sleepy. . . . "Cold treatment" still a hot subject.

Unexpected Crisis in Heavy Ammunition

Again emphasizing what a mechanical war this is, Allied troops on the Western front have already received from the United States nearly three times as much equipment as General Pershing's forces received from all our allies in the 19 months of our participation in the first world war, states James F. Byrnes, director, War Mobilization and Reconversion.

"Our present military shortages are not a product of our failure or our mistakes. They are a product of our successes," continues Mr. Byrnes. "We are running months ahead of our military timetable. Hence, we must obtain from our war factories today material that was not scheduled for production until next March."

At the middle of November Gen. Eisenhower's troops were using more artillery ammunition than we were currently sending them. In the Pacific General MacArthur's forces used as much 105-mm. ammunition in November as they did for the entire previous period of the war, starting Dec. 7, 1941. On Leyte, the preponderance of American heavy artillery caused killing of at least ten Japs to one American.

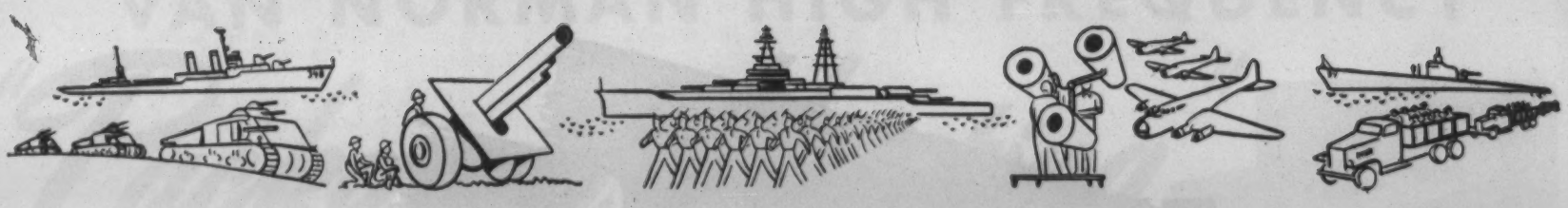
To meet demands from the front, hot shells are being loaded into freight cars at factories here as soon as the TNT inside them solidifies. Some are being flown to front lines by long distance airplanes. We have had to ration ammunition at the front.

If the total munitions program is to be met, average production in the last four months of 1944 must be 8% higher than that of August and 6% higher than the peak production reached during December 1943 and March 1944. The continuous decline and the anticipated cutbacks in the munitions program make it quite probable that the peak in production has been passed.

In recent months the emphasis has been on big guns, shells and bombs. Heavy artillery saves lives. When our troops seemed stalled in Normandy, it was actually the case of awaiting arrival of the "Long Toms" and 240s. Then see what happened! As we started invading Germany, the Nazis used more and more heavy artillery. Capt. William Friedman, back from the Western Front on a brief mission, states: "German artillery fire is the heaviest in two years. We get a heavy Nazi shell in return for every one we throw."

Ammunition, Rockets, Robots

Despite the tremendous consumption of ammunition, we are more effective in its use. Thus, about one-third as many rounds of ammunition are now required per plane brought down as at the time of Pearl Harbor, according to Rear Admiral George F. Hussey, chief, Bureau of Ordnance.



Furthermore, "we are expending in anti-aircraft practice ten times as much ammunition as we use in battle," said the admiral. "We think it is well spent."

Highlighting the increasingly vital role of rockets as a weapon of war, the Navy says that when at peak production the program will be $100,000,000 per month, a figure equalling total monthly procurement of all Naval ammunition now.

Interesting is the fact that 1000 to 2000 robot bombs, Germany's V-1 weapon, have been ordered for the Army Air Force for experimental purposes. The first successful ones have already been produced. Pieces of captured German V-1 bombs were flown to Wright Field and even better ones constructed by us—and in just 17 days after receipt of the first German fragments. The German product was found manufactured of low carbon steel, with a small amount of aluminum in the radiator. Welding is standard, but with workmanship of highest quality.

It first puzzled American engineers to get the motor started. Eventually they found it necessary to force 200 p.s.i. of air against the radiator. The engine will run on ordinary low test gasoline. The control system is an intricate device composed of air-driven gyros, a preset altimeter, a precision compass and an air log. Controls are intended to set the launched bomb at the correct altitude, head it in the proper direction and hold it on course. The air log measures air miles and at a preset distance, arm the warhead, cut lines leading to the engine, point the bomb down, lock the elevators and drop two unequal spoliers from the elevators to give the bomb a spiral descent.

Our first bomb to fly was constructed of both German and American parts. Our robot bombs will be held in readiness in case they are needed. Apparently there is no current definite plan to use them.

Preparing for Enforcing Peace

"Let's Beat Obsolescence" was the heading of a piece in our October issue. We concluded: "The time is near when we unscramble our war equipment (at war's end, of course). Let's scrap most of it with a bold, decisive hand. Let's retain our 'know how,' blueprints, skeleton plants and machinery, ever using imagination on new weapons. Let's beat obsolescence to the punch. Let's retain mostly a strong potential for defending ourselves again when necessary."

Writes a reader concerning that piece: "As long as people do not interpret the 'strong potential' as being lots of plans on piles of paper, we are safe. Both the Army and Navy have never really had a research and development program, through no fault, however, of the Services. Our good, verbose congressmen never appropriate money for such activities.

"To beat obsolescence, we must have clever engineers, trial (or pilot) models to be tested and experimented with—and a well-financed developmental program with adequate public interest so that patents and patent rights of potentially valuable defense developments can be secured and developed to the point of usefulness."

The magazine, *Army Ordnance*, editorializes: "Military armament now stands at the threshold of unknown vistas, the ends of which seem to be limitless. Electronics, atomic energies, rockets, jet propulsion, to say nothing of metallurgical, chemical and plastic progress, all pave the way to realms of research formerly unknown to the artillerist and tactician and even now unpredictable to the scientist. Let no one snicker at the thought of explosive forces powerful enough to shatter targets now relatively invulnerable to RDX, TNT and our other most potent substances.

"From our great private research laboratories, from our educational institutions, and from our technical and scientific societies must come the prosecution of particular ordnance research projects."

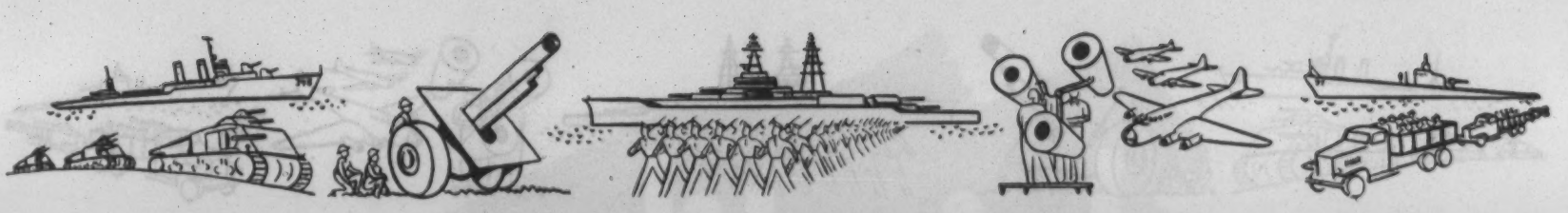
Stated Maj.-Gen. Levin H. Campbell, Jr. recently: "The record of weapon research and development until 1940 is not a glorious one. It was a great day ten years ago when $7,000,000 was appropriated in one year, not for research and development, mind you, but for the operation of the entire Ordnance Department of the Army—its arsenals, depots and proving grounds. Armament progress needs the impetus of free competitive research. It will never be at its best under bureaucratic control, but will thrive only when the brain power of our Nation at large is given to the task. The traditional view-

Wounded Veterans Efficient

Americans may be shocked by the many permanently maimed service men that appear in public. Europe, suffering more severely in the first world war than we, is already hardened. Yet nature usually compensates. One who loses sight develops more keenly his sense of smell, hearing and touch. The one-legged swimmer is often the champion.

Physically impaired factory workers are just as efficient as their unimpaired fellows, a conclusion arrived at by a group of Government agencies that studied 300 factories. They found that 87% of the 63,382 impaired workers were just as efficient as normal workers. The 8% reported as more efficient outweighed the 5% who were less.

Moreover, 51% of the handicapped had better accident rates, 38% had "just as good as" and 11% more accidents than their normal mates. As to absenteeism, 49% of the lame had better records, 44% "no worse than" and 7% were absent more often. Job changes were less frequent, with 58% having a better record, 31% the same and 11% higher turnover than the regulars.



point of Army Ordnance is to utilize the facilities of private industry."

Bugaboo: Standardization

Differing standards in the United States and Britain have already added at least $100,000,000 to the cost of the war, stated William L. Batt, United States deputy member of the Combined Production and Resources Board, at a recent meeting of the American Standards Assn., the Society of Automotive Engineers, and the American Society of Mechanical Engineers. The meeting was called to present the findings of a recent international conference on screw threads at London.

Among the related items on which standardization is imperative are truncated Whitworth threads, cylindrical fits, high duty studs in light alloys, pipe threads, screw threads for compressed gas cylinder outlets, acme threads, buttress threads, instrument threads, unification of screw threads, and design and drafting practice.

The main difficulty in America in the production of the Whitworth form of thread concerned the rounded crests and roots, involving special tooling problems that do not arise with the American thread. American delegates proposed the adoption of the truncated form of Whitworth thread. Favorable action as results of the conferences are expected.

Speaking of lack of standardization, it is appropriate to mention an item appearing in the "House Organ Notes" in the news section of this issue. The U. S. produces and supplies at least ten times as many spare parts for ordnance as the Germans to maintain the same amount of ordnance due to lack of standardization and to distance to fighting fronts.

Hitler compelled use of military trucks in peace, with all parts interchangeable. The U. S. had 135 producers of trucks, with difference of models and interchangeability. Today the same medium U. S. tank is powered by four different kinds of engines.

Where Rolling Is Skill

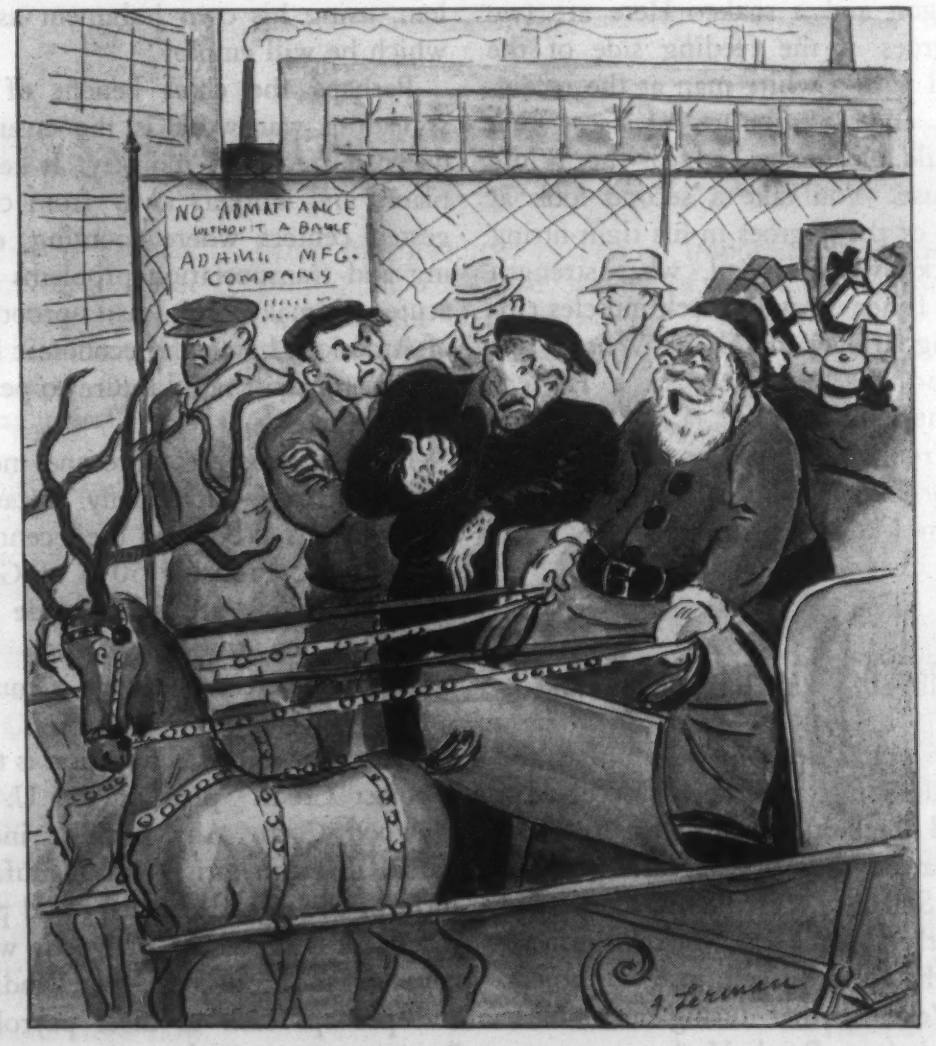
In the historical books on the iron and steel industry we have read much of the old-time rolling mill crews—the catchers, the doublers, the roll dressers, etc. In the books, their skill was painted in the same rosy colors as the metal which passed through their tongs.

It was our privilege to watch such a crew in action recently—a throw back to the horse and buggy days. At the Huntington works of International Nickel Co. there occurs some rolling of nickel and Monel sheets, of such small quantity per order, that it is not economical to install modern continuous and highly-mechanical mills. So they use the old-fashioned hand-operated mills and hired crews who were apprenticed in the old time steel rolling mills.

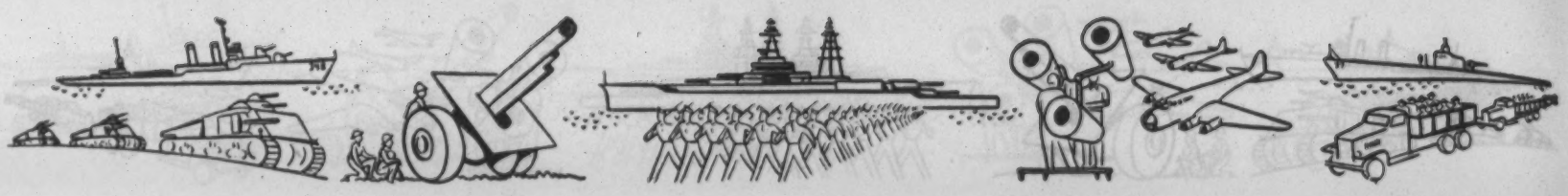
We watched in an aura of fascination. These were indeed supermen, in their grace of body and movement, their haughty nonchalance and cocky demeanor generally. Even their headpieces were different—especially styled transparent visors, worn at a jaunty angle—or perhaps fancy polka-dotted bandannas, fashioned into a cap.

A white hot slab emerged from a furnace—and the game started—with motions as fast as a tennis game. Instead of racquets, tongs. The server

STRESS RELIEF By Gilbert



"Hey, Bud—got your teamsters' union card?"



served; the slab jumped through the rolls; the two receivers grabbed with tongs and sent the thinned slab back again. Then the "doubler" superimposed one sheet upon another and the sheets returned double. In all cases the hand and mill were almost "quicker than the eye."

In another department, and equally spell-binding, is another crew rolling wire rods and subduing some reptile that seems a cross between a fiery dragon and a snake. Here are two negroes at the feeding side of the mill with a white man at the receiving end—a mixture of races that would please the Lady of the White House. You take a second look at one of the negroes in his tight-fitting black sweater. Gad, what strength and litheness, with black muscles rippling all over the place! What a riot as an apache dancer in a Harlem night club!

Trouble is, from the standpoint of labor-management relations, all these fellows know they're good!

Hey Day for the Small Plant

It would certainly seem that the small industrial plant has received a good break during this war. Recently we sat down with a representative of the Smaller War Plants Corp. and absorbed some of the enthusiasm which he displayed in the project.

We recall that during our defense era, before Pearl Harbor, many a small manufacturer was biting fingernails, wondering how he could get sub or sub-sub contracts. "You've got to use salesmanship" was the advice of those days. The smart fellows usually did use just that, but many a plant owner was too confused and awed by the situation to get any place.

Now, through district offices, every small manufacturer is approached regularly to ascertain his available tools, labor supply, and state of backlog of orders. He sits in his swivel chair and orders are handed him. His bids may be high compared with competitors, but if he can show higher production costs than average, his higher prices, if reasonable, will be honored.

He is given many kinds of services. He has a mechanical or metallurgical problem which he puts down on paper and sends to headquarters, who in turn consult the best authorities, and write out a typewritten report. Ultimately the puzzled manufacturer may get a dozen solutions of his problem, using his own judgment as to which he will employ.

Perhaps the chief benefit of so spreading war work is the ensuing decentralization of industry. It keeps plants and workers away from congested centers where rooming, eating and transportation problems are acute. It makes for least uprooting of American home and economic life and means most rapid return to peace pursuits later.

The Germans are more and more decentralizing—but chiefly because the Allies have bombed their centers of industry. Probably 50% of German munitions are now made in plants of ten workers or less. Of course, the percentage here is much smaller.

Somewhat in this connection is the "Project Credit" plan of the U. S. Plywood Corp. Any firm or individual that can satisfy the manufacturer of their good character and potential skill in use of plywoods will have advanced to him merchandise and perhaps cash to meet payrolls. Repayments are made as the contract is carried along toward completion. The manufacturer's engineers will cooperate closely. Service men wishing to reenter business will be given preference.

Yes, it's a good era for the little feller!

Substitute for Counting Sheep

We have the following letter from James D. McAvinney, 283 Selye Terr, Rochester 13, N. Y.:

"I carry on a great number of experiments with metals at my home and have a rare collection of kinds, such as: brass forged, cast iron bent into rings, square and twisted. I have a metal that pulsates like the human heart and a metal that when held in the hand will cause a person to go to sleep. I have spent 45 years of my life working with metals."

"Frigidize," "Cold Treatment," et al

Our minor campaign to find a good nomenclature for sub-zero treatment of metals is like a hot potato—and we're about ready to drop it. Two more suggestions from readers are "low-temp treatment" and "cold temper." Meanwhile, we ruffled at least one man's temper in our original exposition of the need for a good nomenclature—but we won't go into that.

Later we received a good-natured correction from Carlton A. Sheffield, public relations department, Joshua Hendy Iron Works. But first, let's review how it all started. Deepfreeze Div., Motor Products Corp., Chicago, sent out notices that 'Deepfreeze' is a registered trade mark; that editorially it must be used only as a noun—not as an adjective or verb. Furthermore, when used in print it should appear in all caps, or capitalized and enclosed by single quotes.

Then we commented in our original exposition on how Hendy had innocently stated: "nitrided, chromium-plated, high-speed steel with *Deepfreeze* [Italics, ours], Stellite, or Tantung strips."

Now states Mr. Sheffield: "My usage was 'deep freeze,' uncapitalized and in two words, rather than the coined and merged *Deepfreeze* to which you refer in your editorial. It would seem open to question whether or not the free use in juxtaposition of the words, deep and freeze, both of which are undeniably in the public domain, could be inhibited under a copyright issued for their joint usage."

Dear, dear! Wish we'd never started it!

Dr. Saklatwalla Passes

The American engineering fraternity in general, and this magazine in particular, lost one of our most able metallurgical collaborators and best friends through the death, in an airplane accident in California on November 4th, of Dr. Beram D. Saklatwalla, internationally known consulting metallurgist and authority on alloy steels.

Dr. Saklatwalla was born in Bombay, India, in 1881, received a B. S. from the University of Bombay in 1901, and a Doctorate of Engineering from the Royal Polytechnic Institute, Charlottenburg, Germany, in 1908. The next year he came to the United States, and joined the newly organized American Vanadium Company of Pittsburgh. In 1910 he was made general superintendent of the Vanadium Corporation of America, and from 1919 to 1935 was vice president and research director of that company. From 1938 to the time of his death he had been chairman of the board of the Alloys Development Corporation, Pittsburgh, and consultant to a number of companies.

More than 130 American and foreign patents were awarded to him during his career. His most important recent work concerned the development of a most useful series of low-alloy high tensile steels now being manufactured by several important steel companies. In 1924 the Society of Chemical Industry awarded the Grasselli Medal to Dr. Saklatwalla, and in 1942 he delivered the Richards Memorial Lecture before the Electrochemical Society in New York.

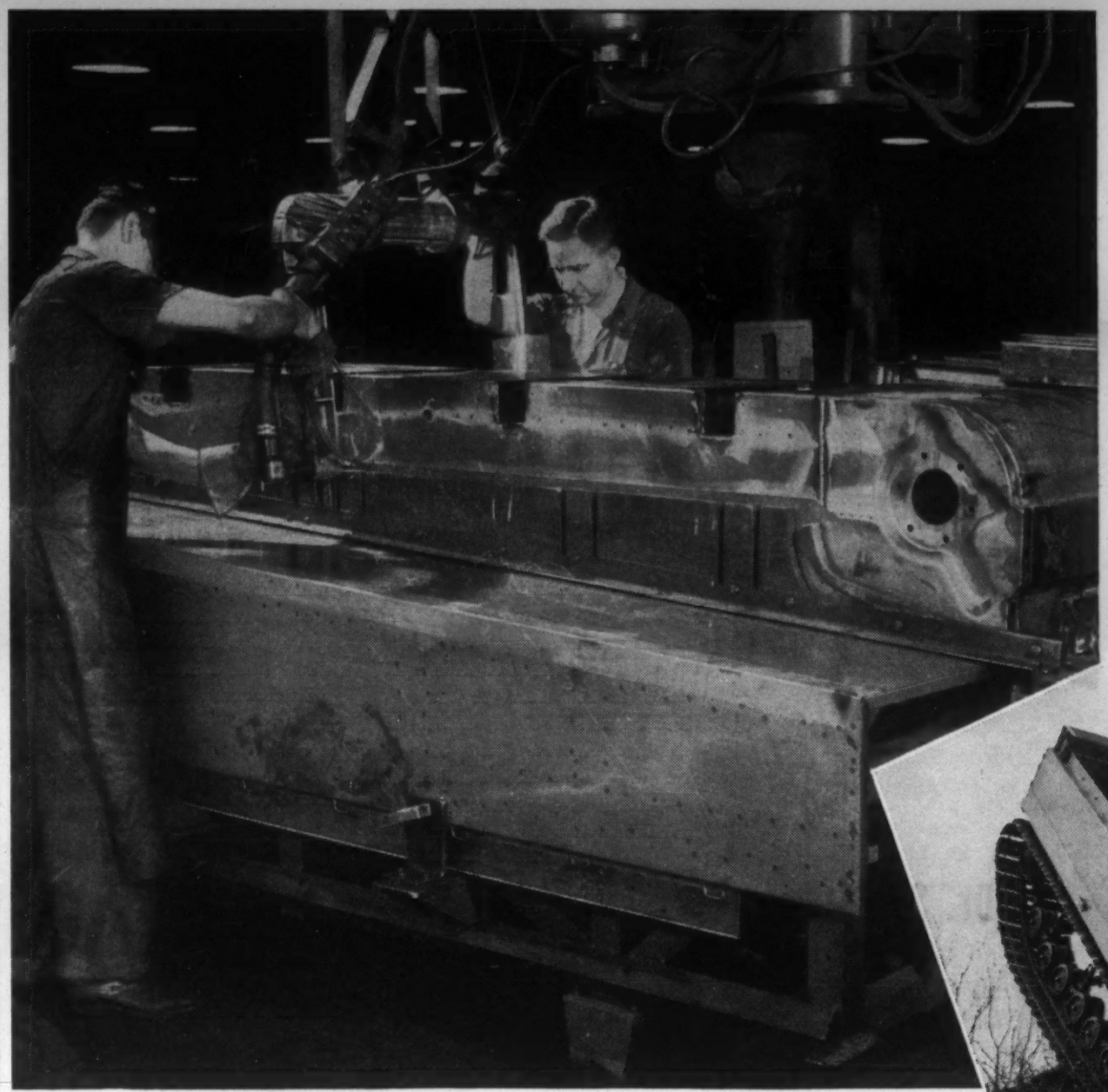
The publishers, editors and long-time friends of M & A feel a special sense of loss in Dr. Saklatwalla's passing, for it was he who originally conceived the idea of publishing this magazine in 1928, marshalled the support of an informal committee of leading engineers and metallurgists in 1929, persuaded the present publishers to undertake the publication of METALS & ALLOYS, and assisted greatly during the uncertain days of the magazine's early history.

—The Editors

What Are the "Metal-Working" Industries?

In the preceding issue of METALS AND ALLOYS we discussed editorially the convergence of materials and methods as a single engineering problem, as opposed to the traditional concept that the materials out of which a product is to be made and the methods and processes to be used in its production can be separately determined. We showed how and why the materials engineer must be intimately familiar with processing methods on one hand, and the process or production engineer with the characteristics of individual materials on the other. Each increasingly influences the decisions of the other, and more and more their decisions are being made in consultation or by an engineering executive who coordinates their functions and activities.

The editorial then re-affirmed this magazine's policy of concentrating on this field—engineering materials and processing methods used in the metal-working industries—and of correlating and coordinating the interest in materials and methods shared



Welding the hull for a "Weasel." Three submersion tests are made to assure water tightness.

Deep mud or steep hills cannot stop the fighting "Weasel."

THESE "WEASELS" FIGHT

Mud, sand, snow, water — they all are the same to the Studebaker Corporation's "Weasel," officially known to the combat forces as the M29 cargo and personnel carrier. Powered by a standard six-cylinder Studebaker Champion engine, this track-laying vehicle is designed to strike swiftly and stealthily over a greater variety of terrain than any other military conveyance.

Inland's part in the production of "Weasels" was to furnish 18-gage Hot Rolled Pickled Sheets for the all-welded, watertight hull; 7 and 9-gage steel for hull reinforcements; 10-gage sheets for cold pressed guide wheels; 13-gage steel for the cold formed bogie wheels and silicon manganese spring steel bars for the four springs on each "Weasel."

Inland has maintained a remarkable record of "on-time" deliveries and uniform high quality—performance that has speeded many "Weasels" to fighting fronts throughout the world.

Inland Steel Company, 38 S. Dearborn Street, Chicago 3, Illinois. Sales Offices: Cincinnati, Detroit, Kansas City, Milwaukee, New York, St. Louis, St. Paul.

Bars, Floor Plate, Piling, Plates, Rail, Reinforcing Bars, Sheets, Strip, Structurals, Tin Plate,. Track Accessories.

INLAND STEEL

by design and materials engineers, production engineers and metallurgical engineers in those industries.

But what do we mean by the "metal-working" industries—just the plants that roll, forge and stamp metals, or those that fabricate metals as distinct from those that produce metals, or what? Are the aircraft and electrical equipment industries, which consume or process plastics and plywood and mica and steatite, as well as metals, "metal-working" industries in our lexicon?

Actually, the term "metal-working" industries is far from a precise designation for the group of industries that we (and most other people) have in mind when we use the term. All of us intend the phrase to refer to those plants whose *chief* raw materials or whose chief products are metallic in nature—or expressed otherwise: those industries whose manufacturing operations involve *primarily* the processing of metals.

In this sense the metal-working industries comprise (a) those that manufacture ships, aircraft, railway cars and equipment, electrical and electronic equipment and appliances, communications equipment, containers, business machines, cameras, hardware, toys, novelties, etc.—all of which consume and process both metals and non-metals, with the metals predominating; (b) those that make motor vehicles, engines of various types, ordnance, machine tools and other machinery, agricultural equipment, pressure vessels, and parts for these—all nearly 100% metallic in construction; and (c) those that produce the wrought and cast metals themselves—industries that are of course 100% metallic with respect to their products.

The so-called metal-working industries should more accurately be called the *materials*-working industries or better still, the product-fabricating industries. More and more these industries are fabricating non-metals and incorporating non-metallic parts into their products. Engineers who once concerned themselves solely with specifying metals or alloys or metal parts for their products now must also consider plastics, fibre, etc. The one-time 1% non-metal tonnage used by the "metal-working" industries has grown to 5 to 8% of their total materials, and in some of those industries much more than that.

Despite its name, and following the trend that finds non-metallic materials of construction increasing in importance in our readers' activities, this magazine has in recent years regarded its field as that of *engineering materials* and processing methods rather than just *metals* and their processing. It is a poor service to one's readers in these so-called metal-working industries (which are really materials-working industries) to compel them to get their materials-information about metals in one magazine and about plastics in another. We have therefore published editorial information on plastics, for example, to a proportion of our total space about equivalent to the proportion plastics represent of the total materials-consumption of our "metal-working" industries.

Metals are still the heavily predominating raw materials of the product-fabricating industries previously listed, and will be for many many years. For that reason the short phrase "metal-working" will probably continue in use as a characterizing adjective for them beyond our lifetime. But in using it we should acknowledge that it is not 100% accurate, that the industries concerned are employing an increasing proportion of non-metallic materials of construction and that a magazine designed to cover the materials and methods used in those industries must give due attention to the non-metals now coming into use along with the metals that have traditionally been their chief materials.

—F. P. P.

Distinguished Service Awards

The Ordnance Distinguished Service Award has lately been awarded to several of the leading engineering and metallurgical technical societies in recognition of their highly merited and valuable contributions to the war effort and to ultimate victory. The Society of Automotive Engineers was the first to receive the award, followed very recently by the American Society for Metals and the American Society for Testing Materials. Latest but not least is the bestowal of this award on the American Iron and Steel Institute. Although many individual steel and metal working plants fly the pennants of Army-Navy E and Maritime M awards, this later award recognizes the steel industry as a whole. And how deserved it is—the war would have been lost except for the American steel industry!

Commenting editorially on this award, the *New York Times* says that "in no other branch of American industry has the teamwork which characterizes our war efforts been better displayed than here. Cooperation between steel men and the Ordnance Department made possible mobilization plans for the industry which, while not utilized to the full, are estimated to have saved at least six months in reaching full ordnance production and hence countless lives."

It is pointed out that the basis of this phenomenal performance has been the teamwork among companies of the industry and the patient, unspectacular but vitally important committees of the Institute. This has resulted in records of output broken, in the new N.E. steels born of war shortages produced, some of which are regarded as better than the ones they replaced, in the substitution of steel cartridge cases for the brass, and in other noteworthy feats in metallurgy, engineering and in manufacture.

As the editorial correctly states—"continuance of cooperation within the industry and by it with the armed services will be an assurance of preparation for any future emergency which may arise." The Institute is doing a splendid work in its constantly expanding service to the steel companies and to the public.

—E. F. C.

Blast Treatment of Metals

—for Cleaning and Peening

by EDWIN LAIRD CADY

Airless blast (Rotoblast) cleaning machines putting the finishing touches to the outside of 500-lb. bombs. Courtesy: Pangborn Corp.

A Materials-and-Methods Article The use of sand-blast and shot-blast processes for cleaning metal parts or for improving the mechanical properties of metal surfaces has been accelerated by wartime needs for better methods and materials. Mr. Cady's article outlines the reasons-for-use and the established applications of blast treatments and provides some practical hints for getting the most out of blast equipment and processes.

THE IMPINGEMENT OF BLASTS of solid particles such as sand or shot upon metal surfaces is an industrial process which has been developing so rapidly that it has gotten away ahead of the thinking of many engineers who could make profitable use of it.

In fact, this process has outrun its nomenclature. Originally called "sand blasting" because the solid particles almost always were sand, it later was called "abrasive blasting" or "blast cleaning" because the particles might be steel shot, steel grit or many things other than sand but its main purpose still was to clean by abrasion. Now the purpose very often is to strengthen the metal by peening its surface, or to create some other effect in which no cleaning at all is intended. For example, before the blast peening of the connecting rod of one engine is begun that rod is not only completely cleaned but is ground until its surfaces are no rougher than a 150 micro-inch reading on the profilometer.

Thus the engineer may continue to talk about sand blasting or abrasive blasting when those operations are all he is performing by the solid particle blast impingement method, but to visualize all that this process can do for him he probably will have to think in some such term as "blast treatment."

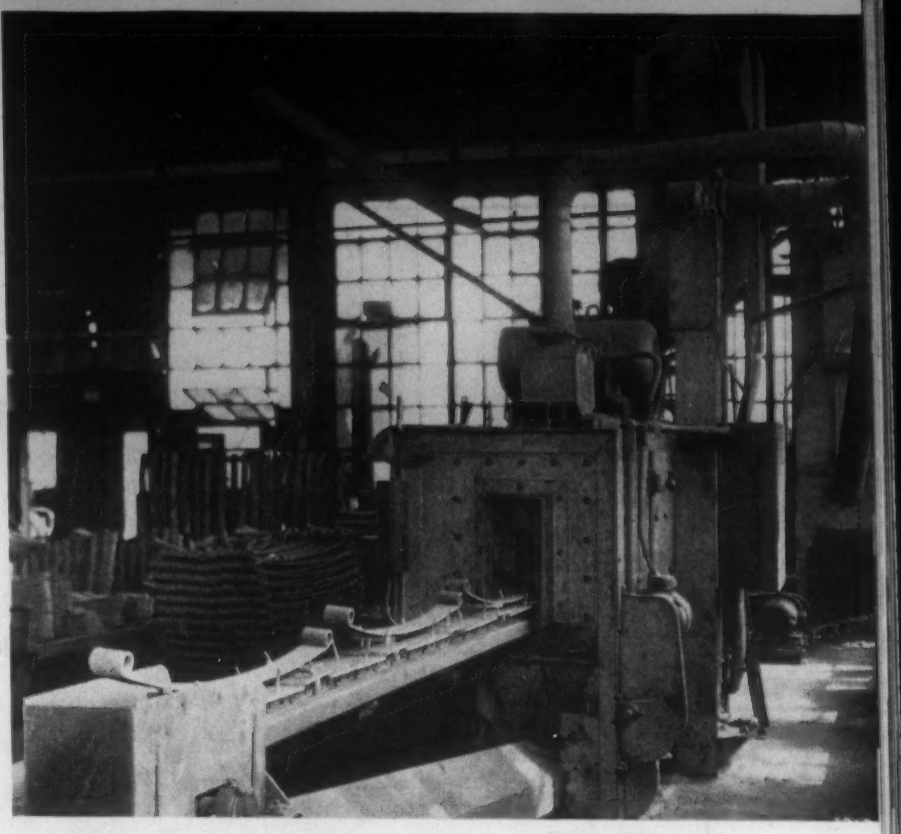
Applications

All of the possible uses of this process have not yet been explored, even in the experimental laboratories of the makers of the supplies and equipment for it. In general, they fall into these categories:

1. Cleaning, such as the removal of foundry or heat treatment scale.
2. Special finishes, such as matte.
3. Surfacing to permit plate, lacquer, cement and the like to secure a better mechanical bond to the blasted metal.
4. Inspection, such as the blasting of heat treated pieces to reveal soft areas on their surfaces, or to prepare for Magnaflux. Much of cleaning is in preparation for inspection.
5. Peening, to pre-stress surfaces and thus add to the fatigue resistance, the abrasion resistance and the resilience of the pieces. This application is among the fastest-growing metal-working developments now in the public eye.
6. Correction of surface defects. Many pieces which show surface defects under the Magnaflux or other close limit test methods, can be peened and salvaged.

Combinations of these operations can be performed, of course, in single passes of the work through the blast stream. Cleaning of heat treated work and inspecting it for soft spots is one example, peening of steel while giving it a special finish is another. Cleaning, peening and surfacing for plating is a third. Working out the most profitable uses and combinations of uses is an art so little developed by shop men that it is a common custom to refer such problems to the makers of supplies and equipment for study in special laboratories.

Blast cleaning, widely used for cleaning forgings, castings, punched parts and metal parts generally, competes to varying degrees with pickling, tumbling, electrolytic cleaning and even flame descaling. Once considered primarily a "small-part" process, the method is gaining in use for cleaning large objects



Unloading end of Wheelapeening cabinet for peening and cleaning leaf springs. Courtesy: American Foundry Equipment Co.

like Diesel cylinder blocks, turbine castings, pressure vessels, tanks, etc. while they are in place.

Its competitive advantages include the removal of rust and scale without danger of hydrogen embrittlement and without the smut that sometimes forms on certain alloy steels during cleaning and pickling; the production of a truly clean and dry surface that requires no other treatment prior to finishing; and demonstrable operating economies and mass-production efficiency for many types of work. The previously-mentioned ability to peen or surface-compress the work is an additional advantage that has a distinct materials-engineering appeal for many jobs.

The surface peening application, now engaging the attention of a growing number of engineers and production men, represents a major contribution to strengthening the surface and thereby improving the life of parts subjected to vibration service or "fatigue." Shot peening is simply a cold-working operation that produces a shallow layer of surface metal which is harder, stronger and less ductile than the underlying metal. The chief advantage of shot peening is that through the formation of this surface layer of metal in a state of compressive stress, it increases the "fatigue strength" or "endurance limit" (resistance to cracking or breaking in repeated-stress or vibrational service) of the part and either lengthens its life or permits the use of heavier fatigue-loads than can be used with unpeened parts.

To a certain extent shot peening can replace heat treating or surface hardening if distortion must be avoided. It is being applied to finished parts, such as springs to specific areas (e.g. fillets) on structural or machine parts or to the body of a shaft to resist pitting-corrosion or "corrosion-fatigue." Shot-peened gear teeth have improved resistance to pit-corrosion and to wear. It has also replaced polishing, for shot blasting has long been used for cleaning parts and the blast intensities used for peening have a distinct polishing effect.

The effect of shot peening on the fatigue strength of various metals is given in the accompanying table, taken from a recent report of Professor H. F. Moore (and available from American Foundry Equipment Co., Mishawaka, Ind.).

Effect of Shot Peening on Fatigue Strength (Compiled by H. F. Moore)

Metal	Stress Cycle	Endurance Limit for 10 000 000 Cycles of Stress, p.s.i. NOT Peened	Endurance Limit for 10 000 000 Cycles of Stress, p.s.i. Peened	Unpeened Specimens, Polished	Gain in Fatigue Strength for Peened Specimen, per cent	Reported by
0.85% C Steel Spring Wire....	Torsion, 20 000 p.s.i. to maximum	95 000	135 000	NO	42	Zimmerli
SAE 1095 Steel Music Wire....	do.	90 000	135 000	NO	50	do.
18-8 Stainless Steel Wire.....	do.	65 000	110 000	NO	69	do.
13-2 Stainless Steel Wire.....	do.	80 000	120 000	NO	50	do.
Phosphor Bronze, SAE 81 Wire	do.	35 000	50 000(c)	NO	43	do.
18-8 Stainless Steel.....	Torsion, zero to max.	46 000	92 000	NO	100	Wahl
NE 9470 Steel, carburized.....	Reversed Flexure	100 000	152 000	NO	52	H. F. Moore
SAE 4032 Steel, carburized....	do.	100 000	150 000	NO	50	do.
NE 9420 Steel, carburized.....	do.	100 000	153 000	NO	53	do.
SAE 1020 Steel Plate.....	do.	34 000	38 000	YES	12	do.
SAE 1050 Steel Plate.....	do.	37 000	47 000	YES	27	do.
SAE 1045 Steel, annealed.....	Reversed Flexure	39 500	43 800	YES	11	Lessels & Murray
SAE 1045 Steel, water quench and draw	do.	80 700	75 000	YES	—7(a)	do.
SAE 9260 Steel, oil quench and draw	do.	108 600	106 000	YES	—3(b)	do.
Armco Iron	do.	26 800	27 000	YES	1	do.
SAE X4340 Steel, oil quench and draw	do.	66 000	78 000	YES	18	do.
SAE 1045 Steel, normalized and tempered	Reversed Flexure	31 000	32 000(d)	YES	3	Horger & Neifert
	do.	31 000	34 000(e)	YES	10	do.
	do.	31 000	37 000(f)	YES	19	do.

(a) Residual stresses due to heat treatment may have offset benefits of shot peening.
(b) Peened specimens showed much longer life under stresses above the endurance limit.
(c) For phosphor bronze there may be a reduction of endurance limit under more than 10 000 000 cycles. However, there is shown a distinct increase of strength due to peening.
(d) Peened with No. 28 shot. (e) Peened with No. 19 shot. (f) Peened with No. 22 shot.

Sand and Shot Selection

Blast treatment equipment to accomplish these purposes, has been making rapid strides during the past ten years; especially rapid ones during the war. It contains enough factors which the methods, process and production engineer can control singly, in combination or in integration so it deserves as much study as metals cutting, heat treating or any other industrial art. Among these factors are:

1. The particles. Their size, weight, sharpness or smoothness, resiliency, durability and the like.
2. The force of impingement upon the work.
3. The angle and volume of the blast.
4. The means of feeding the work to the blast, including positioning, materials handling, and the like.
5. The removal of waste products such as broken down particles, scale, etc. including the control of dust.
6. The recovery of sound particles for re-use.
7. Safety.

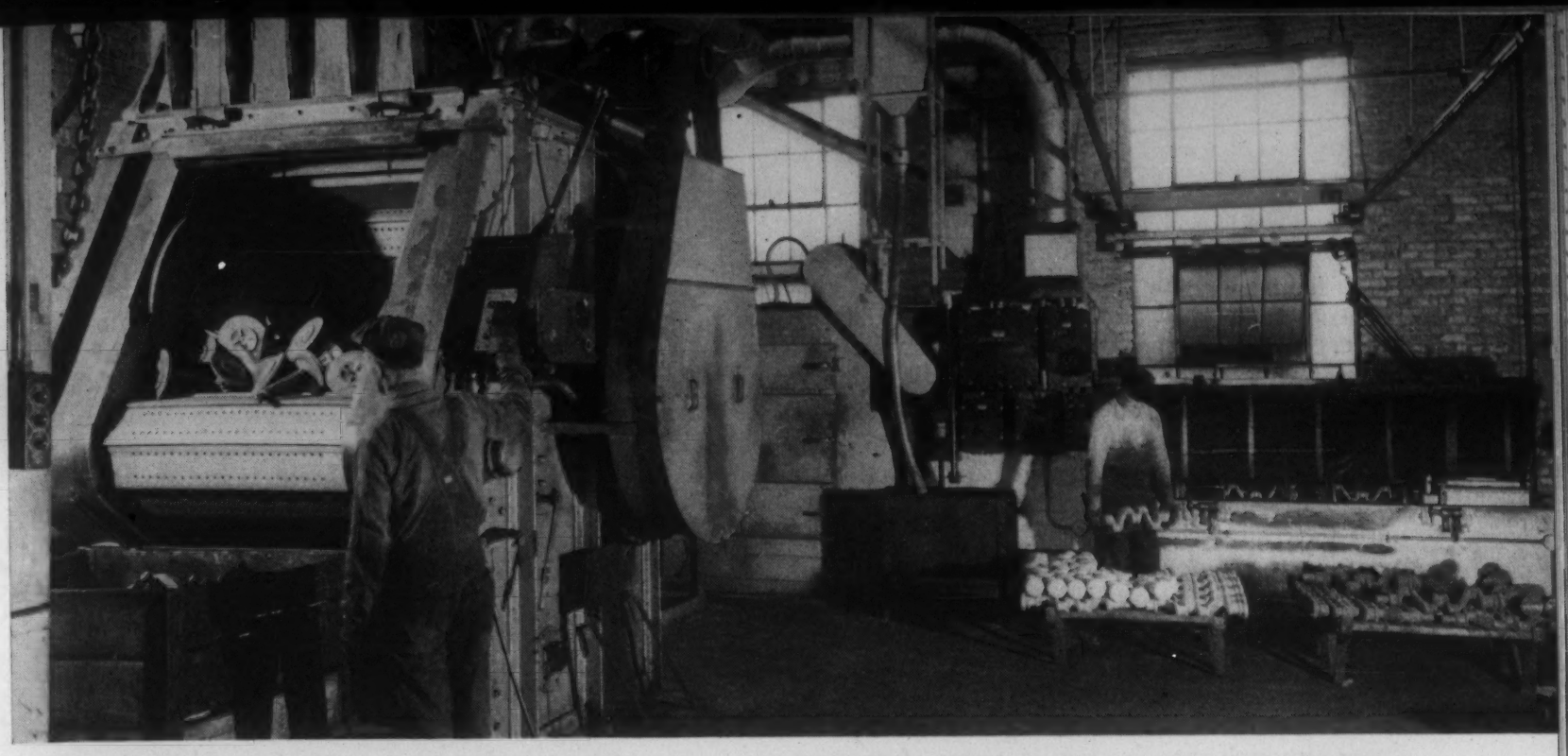
Sand is the type of particle with which the largest number of users of this process are most familiar. With equal force and velocity of impact upon the work, sand appears to have the highest abrasive qualities. Thus boron carbide nozzles, among the hardest and most durable offered for abrasive blasting work, are commonly guaranteed for 1500 hours of working life when used with steel shot or grit but erode so much faster with sand that this guarantee is reduced 50% or to 750 hours.

Ordinary bank or beach sand can be used for very few purposes. The individual grains have lines of cleavage within them, and break up so easily that there is very little recovery for re-use. This adds to the dust problem, in addition to being uneconomical. The most desirable sands come from the middle west. Their grains are round and generally will wear down evenly so they can be re-used many times before wearing out.

Special sands for blast cleaning are sieved into carefully graded sizes. They thus may be selected not only for the type of cleaning to be done but also for kinds of finishes desired on surfaces. But the companies which are experimenting most widely with blast peening do not seem to be using sand for this purpose. And the blast machines which use centrifugal force (wheel type) rather than streams of compressed air or of water to obtain their blasts, need the heavier particled and less abrasive steel shot and grit; sand is not recommended by their makers.

Equipment which generates the blast by entraining the particles of high pressure streams of water, can use ordinary foundry sand. In fact, after once being started up for cleaning castings these hydraulic machines may need no replenishing of their sand supplies at all. Their original sand supplies plus sands knocked off from the castings, fall into separators which remove the scale and the fines. Enough sand may come from the castings to give the machines all they need and to provide a surplus which may be used in the foundry.

Steel shot and grit is made in wide ranges of sizes. The shot is round, while the grit is deliberately made



Smaller forgings (at left) are cleaned by blasting while being tumbled; larger forgings (at right) are blasted while turning on rolls. Courtesy: International Harvester Co.

to have sharp points for more rapid abrasion. Various sizes of shot may be mixed together, or mixtures made of shot and grit, for special finishes on the work or to solve other problems. The particles are made of specially selected and treated steels or of chilled irons. Their hardnesses, resiliencies and other properties are carefully controlled. In fact, some of them might be classed with precision made tools. The possibilities of varying their mixtures to obtain greater speeds and economies of operation or special finishes and depths of peenings, etc., upon work, are so complex that many of their makers operate special laboratories to which users may submit work for experiment and for developing the best combinations and procedures.

For shot peening the shot most widely used is called "steel" shot although really a chilled cast iron. Malleableized chilled iron shot is also used and in recent months a special heat treated shot has shown marked advantages and is increasing in use.

Other types of particles may be used. They include everything from the special abrasives ordinarily used in grinding wheels, to cereals and leather pellets.

Selection of type of particle to be used is a problem which must be faced whenever a new blasting job is to be done. And this problem may be arising in many plants because the war is causing shortages of the steels of which shots and grits are made. In making selection, consideration is given to such factors as:

1. Kind of blasting equipment in use.
2. Training and skill of labor available.
3. Toughness, hardness, thickness, etc., of scale to be removed.
4. Metallurgy of the part to be treated.
5. Finish desired.
6. Depth and character of peening desired.
7. Time cycle permissible for process.
8. Endurance of abrasive in operation.
9. Effect on maintenance of equipment.
10. Cost of material.

When one abrasive is working with fair satisfaction but it is desired to test another which may improve performance or reduce costs, it is necessary to consider all of the performance factors. Actions which may be taken include:

1. Selection of a significant test run in terms of amounts and varieties of work to be blast treated.
2. Cleaning the equipment thoroughly to remove all of the old particles.
3. Starting the test with all rapid wearing parts of machine installed brand new but weighed before installation. This includes nozzles, wheel parts, end guards, liners and the like.
4. Keeping careful record of the amount of particles originally fed into the machine, and of the amounts added during the test.
5. Inspecting the particles in use at least twice per shift, or otherwise making sure how they are standing up.
6. Testing the machine setting, the operating cycle, and other factors to see if the new material is doing better work or can do the same work in less time.
7. Reweighing of the wear parts of the machine, and inspecting to determine the effect of the new particles upon maintenance costs.
8. The usual final comparisons made in all tests of operating materials.

Equipment for Blast Treating

The kinds of equipment available for blast treating give the engineer wide choices as to methods.

First in line is the original sand blast. It can handle either sand or steel particles, but its usual air pressure is 90 pounds, which through the usual 3/8 in. nozzle enables it to deliver about 50 lbs. of particles a min-

Wheelabrator Tumblast with conveyor and sorting mechanism used for blast-cleaning of small automotive castings. Courtesy: American Foundry Equipment Co.

ute at only 1860 ft. a min. velocity. Nevertheless, it is capable of wide ranges of work, is the least expensive in first cost and is low in maintenance. Engineers of long experience in the field believe that there always will be more compressed air sand blasts in the field than of any other type of blasting equipment.

Second is the airless blast. This can deliver 300 or more lbs. of particles a minute, and at velocities of 12,000 ft. a min. or more. It does not use sand, but must have steel shot or grit. The force of impingement is great enough so the peening effect can be high. The blast is generated by centrifugal and tangential forces set up while feeding the particles to blades on a rapidly revolving wheel, and the wear of this wheel and of other parts is rapid enough so the maintenance bills can be high in terms of dollars a year although they are low in terms of pennies per volume of work done. For large volume production this method has a tight hold on much of the field.

Third is the hydraulic blast. This has the highest velocity; 18,000 ft. a min. and more. So far as is generally known it does not use any other particles than sand. It delivers from 70 to 100 pounds of sand a minute but also delivers some 200 lbs. of water a minute at pressures exceeding 1200 lbs. Like the compressed air sand blast, the hydraulic blast can work through nozzles which operators direct with their hands, or can be directed into barrels or other closed chambers. The sand supply can be cut off and the water alone used for final washing of the work. Many shops which must have their finished work completely sand free for plating or for broaching and other fine machining, have been dipping the parts in hydrofluoric acid after blasting, or have been washing them in streams of water at 400 lbs. pressure or using other special secondary processes to get rid of the last of the sand. The hydraulic blast with its final high pressure rinsing often eliminates these secondary processes.

Control of the force of the blast, in any machine, can be achieved by changing the sizes and weights of the blast particles, by changing the velocity, and by changing the distance from the nozzle or wheel to the work—for any given velocity at the nozzle or wheel, the force of impingement varies very nearly in inverse ratio to the distance to the work. And as the effects of this force are studied, its control is found to be of higher importance than many blast treaters had suspected. It affects, for example, the depth of the peening effect, the likelihood that sharp edges of work will be eroded or broken, the character of the finish, and the ability to blast treat thin sections without warping or breaking them.

Intensity of Bombardment

The volume of particles fed at a given velocity also can be controlled in modern machines. And this, too, is highly important.

One experimenter believes that changes in this volume can definitely be proven to have deceptive effects upon the testing of the degree to which highly finished surfaces have been peened.

The best available test for this peening—called the "Almen" test, after J. O. Almen of General Motors Research Laboratories—consists of passing strips of steel of predetermined size, thickness and characteristics at predetermined speeds beneath the blast. The peening effect causes the blasted sides of these strips to lengthen slightly, and this lengthening causes those sides to rise so that the originally flat strips become curved. The amount of this curvature along a chord of predetermined length is measured with a dial gauge, and each thousandth of an inch rise along that chord is called one point. A rise of 0.005″ on an "A" sized strip, for example, would be called a 5A peen.

In theory, for a given shot size the coverage of the piece is proportional to the shot volume in pounds an hour; and for a given shot size at a given volume the coverage of the piece and the intensity of the peen are proportional to the speed of travel of the piece beneath the blast.

But this experimenter found that by feeding No. 16 shot at the rate of 28,000 pounds an hour while the piece was traveling at 11.2 feet per minute beneath the blast a 100% coverage with a No. 17A peen was obtained; while by changing no other condition except to raise the speed of travel of the piece to 54 feet per minute a 60% coverage with a No. 21A peen was obtained. In both cases, extent of coverage was measured by observation through a glass.

The experimenter is not ready to make public announcement of his results since to do so would arouse controversy before he has made enough tests to work out all of their implications. But experiments like these are exploring the reasons why the cleaning effects of given sizes and characteristics of particles at given forces of impingement on the work are not directly proportional to the volume of particles fed, and will find the methods by which blast treatments can be made to act faster and better.

Automatic and Mechanized Machines

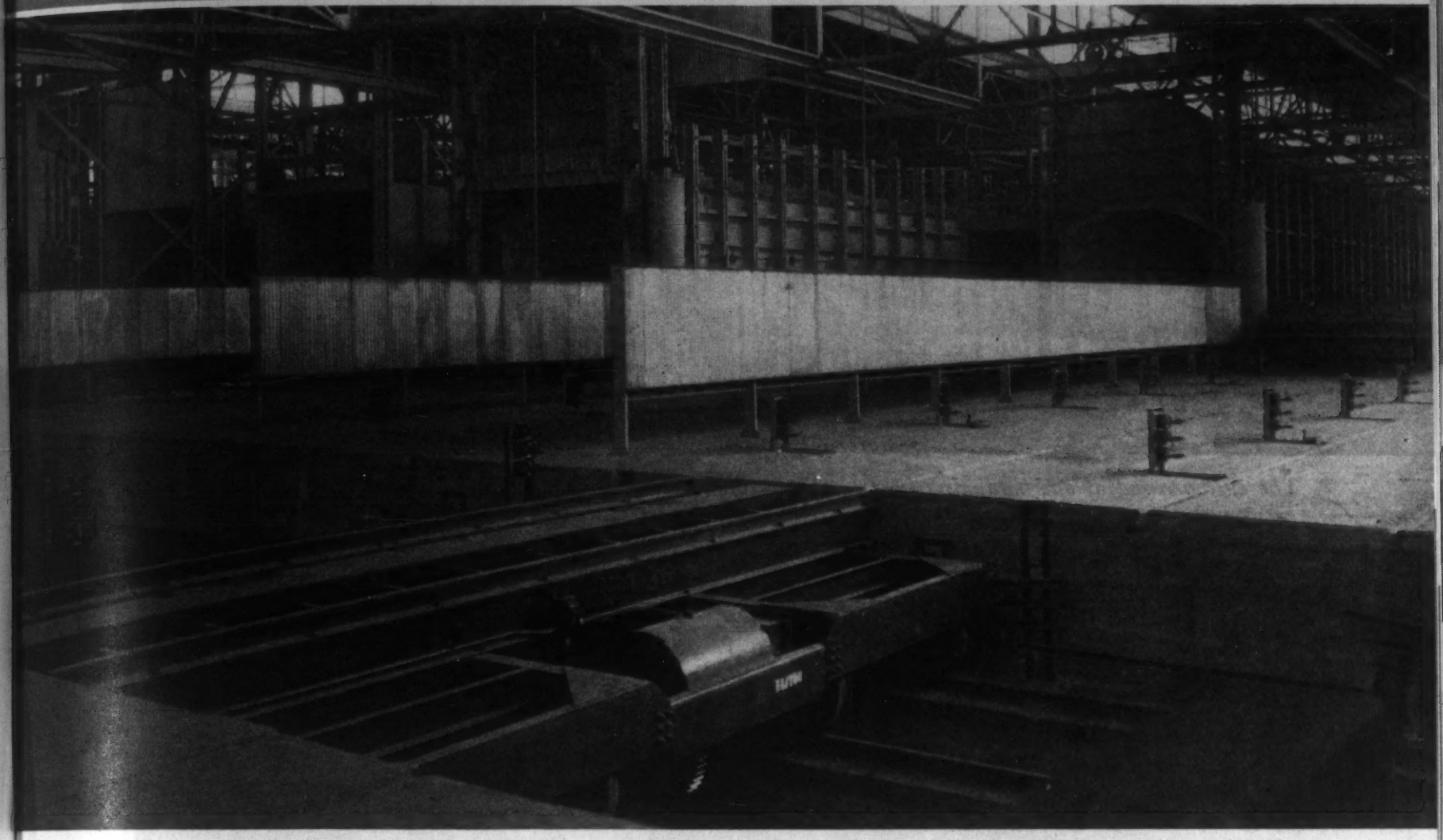
Blasting methods are steadily being reduced to such formulas that the machines for them operate like machine tools, with the operators standing outside, observing the work and changing the machine adjustments very little.

Work travels in and out of these machines on overhead chain conveyors, revolving tables, belt conveyors, rail cars and the like. It is automatically positioned, caused to dwell for proper time intervals, indexed, ejected when finished.

In addition to highly developed standard machines, special machines have been worked out by the hundreds to solve blast treatment problems which have arisen during the war production effort. From these, as well as from the severe testings of the standard machines and of the various types of blast particles, new methods and new treatments are being evolved.

For some time the combinations of possible methods and results will continue to be so complex that the more severe problems, at least, will be referred to special laboratories for tests and solutions. But blast treatment already has emerged as a highly developed and thoroughly controlled industrial art, capable of contributing much more to the metalworking industries than it even now is doing.

A Methods Article Sound furnace design and engineering and the application of advanced mechanization have made possible one of the war's most impressive processing achievements—the continuous heat treating of large cast steel tank components to close mechanical-property tolerances and production requirements in an installation hitherto unmatched in size. The general engineering problem involved and the plant methods and equipment employed to solve it are described in this article.



Visible in this picture are, from left to right, a homogenizing furnace (No. 16), two preheat furnaces (Nos. 15 and 1), another homogenizing furnace (No. 2) and a drawing furnace (No. 3) for tank hull and turret steel castings.

Continuous Heat Treating of Armor Steel Castings

by EDWIN F. CONE

ONE OF THE OUTSTANDING engineering achievements of the war effort has been the development and construction of a large plant for the continuous heat treatment of the large hull and turret steel castings for the U. S. Army's large tanks. The designers and builders of this plant had to provide on a large scale for that comparatively new technique for steel castings—water quenching and drawing.

The General Steel Castings Corp. was requested by the U. S. Army Ordnance to design and construct for the Defense Plant Corp. and to operate a plant for the manufacture of these castings. The Selas Corp. was selected by General Steel Castings as supervising engineers to design the heat treating furnaces and supervise their erection. In general these furnaces followed the design of the continuous furnaces worked out by General Steel Castings engineers at that company's Eddystone Plant and which had been in successful operation for several years. The new Defense Plant Corp: Plant was located in Madison, Ill.

Besides the problem of successfully quenching and drawing these large castings, many other engineering problems had to be solved. The hull castings, cast in one piece, are approximately 22 ft. long and 10 ft.

The entrance end of one hardening furnace (No. 8) and the exit end of another (No. 9), used for hull castings. Note the overhead conveyors in each, and the water-quench tank at the right.

The exit end and the entrance end of the two smaller furnaces (Nos. 11 and 10) for hardening turret castings.

wide and vary widely in thickness. The turrets are of course smaller. To heat treat these products continuously, difficult problems had to be solved. Variations in size, section, ribs and intricacy make uniform and close time-temperature-cycle heat treatment tough. The fact that the foundry was operated only on a 6-day per week basis, and the furnaces on a 7-day cycle presented another problem, and soon.

The overall conception and execution of the job approaches the gigantic and novel. The heat-treating plant covers approximately 163,000 sq. ft.—and contains 13 furnaces.

Ceramic Cup Burners Used

A novel feature of these furnaces is the burner used to fire them. It is a radiant ceramic device which burns any commercial gas pre-mixed with air at definite ratios. The burners, made in various different shapes to suit special applications, are a product of Selas engineering. Those used in the furnaces at this plant are of the cup type and are located all along the sidewalls of each furnace. In the 13 furnaces in the plant there are nearly 4,000 such burners. A cross-sectional drawing of one of the burners in the furnaces shows its design, and how it operates. Depending on the design and application, temperatures

up to 3,000 F. can be commercially attained with such gas-air burners made entirely of precision-molded refractory materials.

Of interest in connection with this discussion is a factor which is vital in making such continuous heavy armor heat treatment a success—the efficiency of the ceramic cup burner in transferring heat, in pattern, into the material. There is no difficulty in attaining the extreme temperature uniformity and control needed in the 13 huge furnaces, along with startling rates of heat delivery to the work.

Further evidence of the heat transfer abilities of the ceramic cup burner may be found in the fact that a 5-in. by 7 in. steel billet has been heated clear through and brought up to a white heat in 14 min. by these burners. It may also be added that a producer of electrolytic tinplate is using facing panels composed of 75 such burners for flowing the tin.

Steps in the Process

The first step in the continuous heat treating of the hull and turret steel castings is accomplished in a group of 6 furnaces as indicated in the floor plan or flow sheet of the continuous process. These 6 furnaces are divided into 2 groups of 3 furnaces each. Furnaces Nos. 1 and 15 are designated as the pre-heat or holding furnaces, Nos. 2 and 16 are the homogenizing furnaces, and Nos. 3 and 17 are furnaces for drawing.

The hull and turret castings are delivered from the foundry of the General Steel Castings Co. at the temperature usually obtaining after being shaken out —the castings are still at a dull red. In the heat-treating process practiced at this plant, these castings must be maintained at that temperature, that is, they must not be allowed to cool off.

To accomplish this, the pre-heat or holding furnaces (Nos. 1 and 15) are provided. These furnaces, about 325 ft. long, are provided with flat bottom cars on which these castings are placed and held in the furnace until the next step in the process. As the foundry only operates 6 days a week, these holding furnaces provide a means of storing castings under heat for the extra day that the heat-treating furnaces operate.

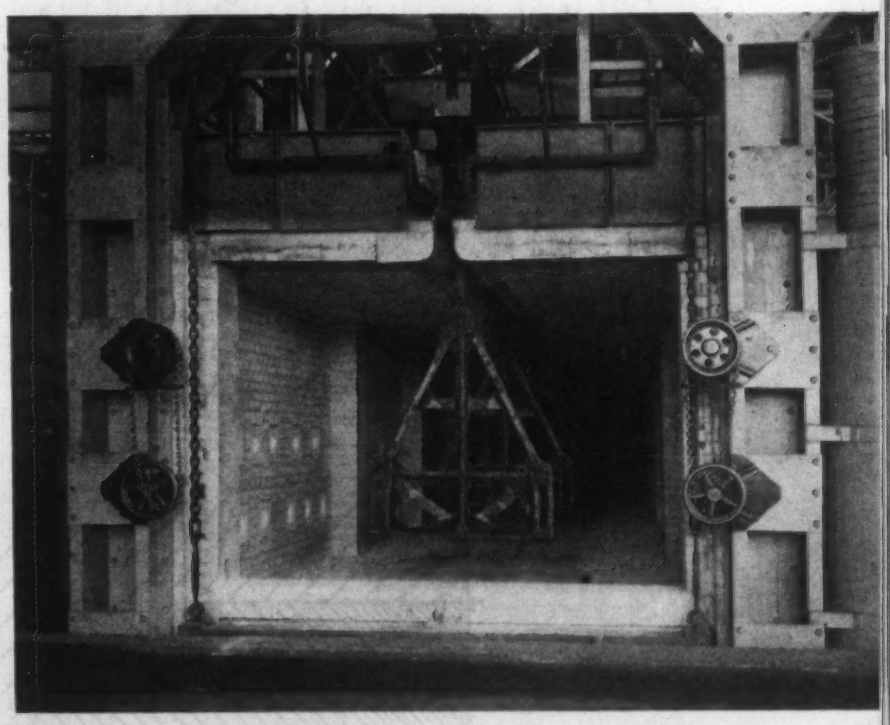
From the No. 1 or No. 15 furnace the castings pass to the homogenizing or No. 2 or No. 16 furnace, also about 325 ft. long, in which they are brought up to a brilliant yellow, held in 12 closely regulated time-temperature steps, thereafter being allowed to cool slowly external to the furnace. After this the castings are progressively delivered, still on transfer or furnace bottom cars to furnaces Nos. 3 or 17. Here they are brought up gradually to just above the black heat temperatures and normalized by bringing them into the open air for fairly rapid cooling. To operate such long draw furnaces with radiant cup burners in the sidewalls only, with no means of forced air convection, and in 8 zones of draw, is most unusual.

Thus in the two sets of 3 furnaces each, a fairly large quantity of castings can be handled on a round-the-clock continuous production basis.

One of the outstanding engineering features of the plant is the mechanical control exercised in the handling of the castings from one step to the next. From stations at certain locations, operators can regulate the movement of the cars supporting the castings as they move from one place to another by the pressing of certain buttons or levers in the electric system. The passage through the zones of the furnaces is also automatically controlled.

After the hull and turret castings are removed from the drawing furnaces, they are subjected to chipping, grinding, etc. and are ready for the final hardening heat treatment in another group of furnaces. Directly in line and parallel to the furnaces just briefly described are 4 sets of furnaces in pairs. Nos. 8 and 9 and Nos. 10 and 11—all of an overhead conveyor design. The two larger furnaces are for treatment of the hull castings, the smaller ones for the turrets.

The castings, placed on cast alloy fixtures suspended from the overhead trolley conveyor, enter one of the larger furnaces, about 300 ft. long and as they pass from one end to the other they are brought up to a quench-hardening temperature. As they emerge they are plunged into a large water quenching tank with the hull castings still suspended on its fixture. To so handle 12½-ton "pieces" is a feat of furnace engineering.



Closeup of the entrance end of furnace No. 11 for hardening turret castings.

Exit end of the 300-ft.-long stress relieving furnace (No. 18), which, like all the others, is equipped with ceramic radiant heat burners.

Engineering Requirements Met

To accomplish the properties desired, the operation of quenching must be carried on in a prescribed brief time so that the castings enter the water at a definite temperature with the temperature of the water rigidly maintained at a certain point. In the case of the hull castings no more than 40 sec. can elapse from the time they leave the last station in the furnace until they are quenched in water—not an easy accomplishment with such large castings when it is considered that to do so 12-ton pieces and their fixtures must be accelerated from dead stop, moved to a position over the quench, decelerated to stop and dropped below water level.

After a definite interval the castings are brought out of the water and introduced into the second furnace where drawing treatment is carried on. In this they travel automatically until they reach the desired temperature at the other end where they are brought into the air for cooling. The two pairs of two furnaces each are capable of handling the entire output of the plant producing both hulls and turrets.

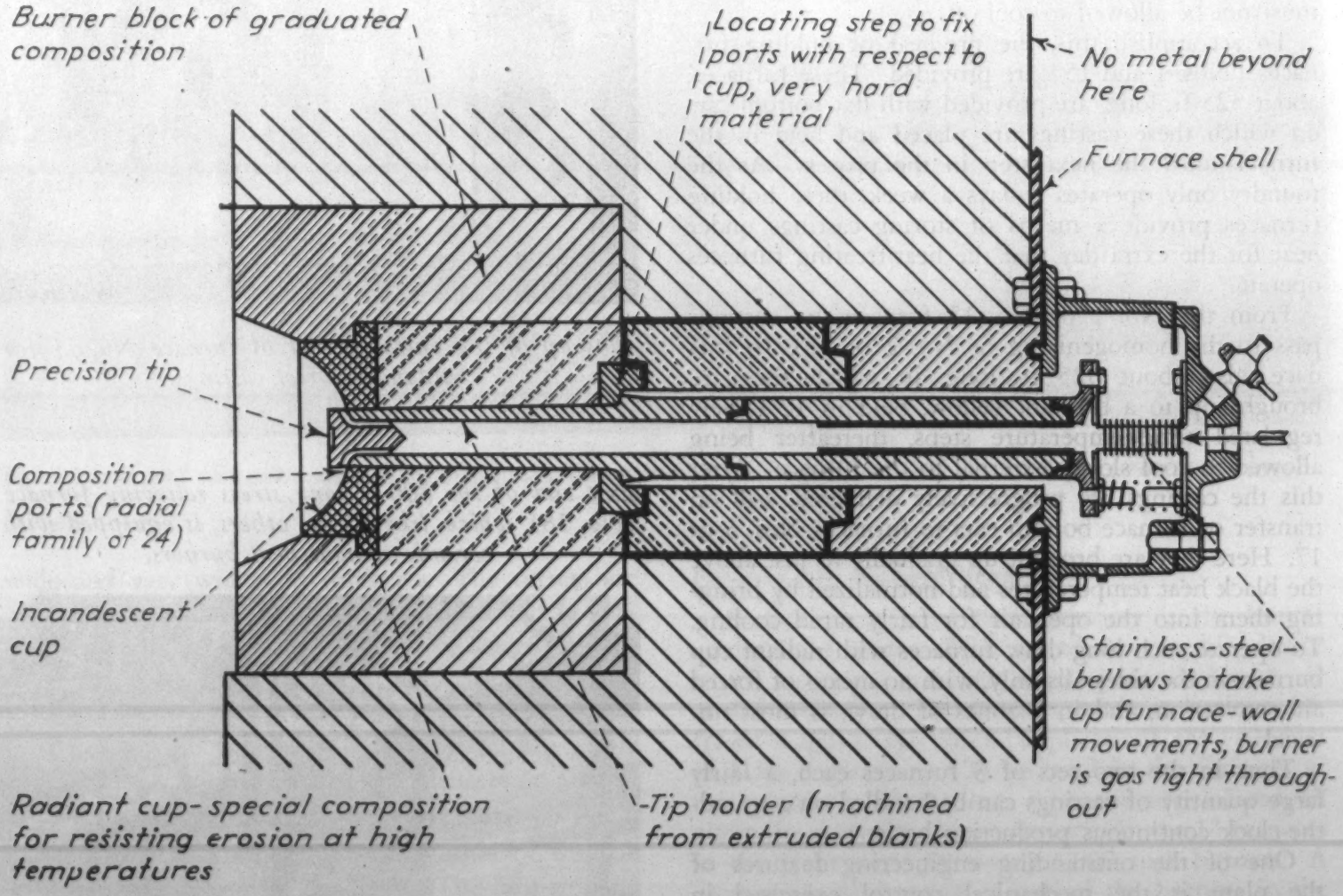
Unfortunately security restrictions and war conditions prevent the revealing of the exact temperatures and cycles involved in this fascinating heat treatment. Extreme tolerances must be observed to insure the hardness necessary to meet certain ballistic tests. There must for example be a definite correlation of the temperature of the castings and the water at the time of quenching. And temperature uniformities throughout the castings as massive and intricate as a tank hull must frequently be within ± 10 F.

After the castings have left the group of furnaces where the hardening—the liquid quench and draw treatment—has been carried out, most of them are in a condition suitable for final grinding and mounting, free of all cracks and defects. In some instances, cracks and defects are found which must be repaired.

Much of this repairing is done by arc welding, a good deal of it at a fairly high temperature. To relieve the stresses which often follow, a special large furnace, No. 18, is provided. This unit is also over 300 ft. long and located separate from the furnaces already described. Its construction is similar to the other car-operated furnaces and is fired with the ceramic radiant heat burners. The repaired castings pass from one end of this to the other and are subjected to a low stress relieving heat which neutralizes such stresses and does not affect the hardness.

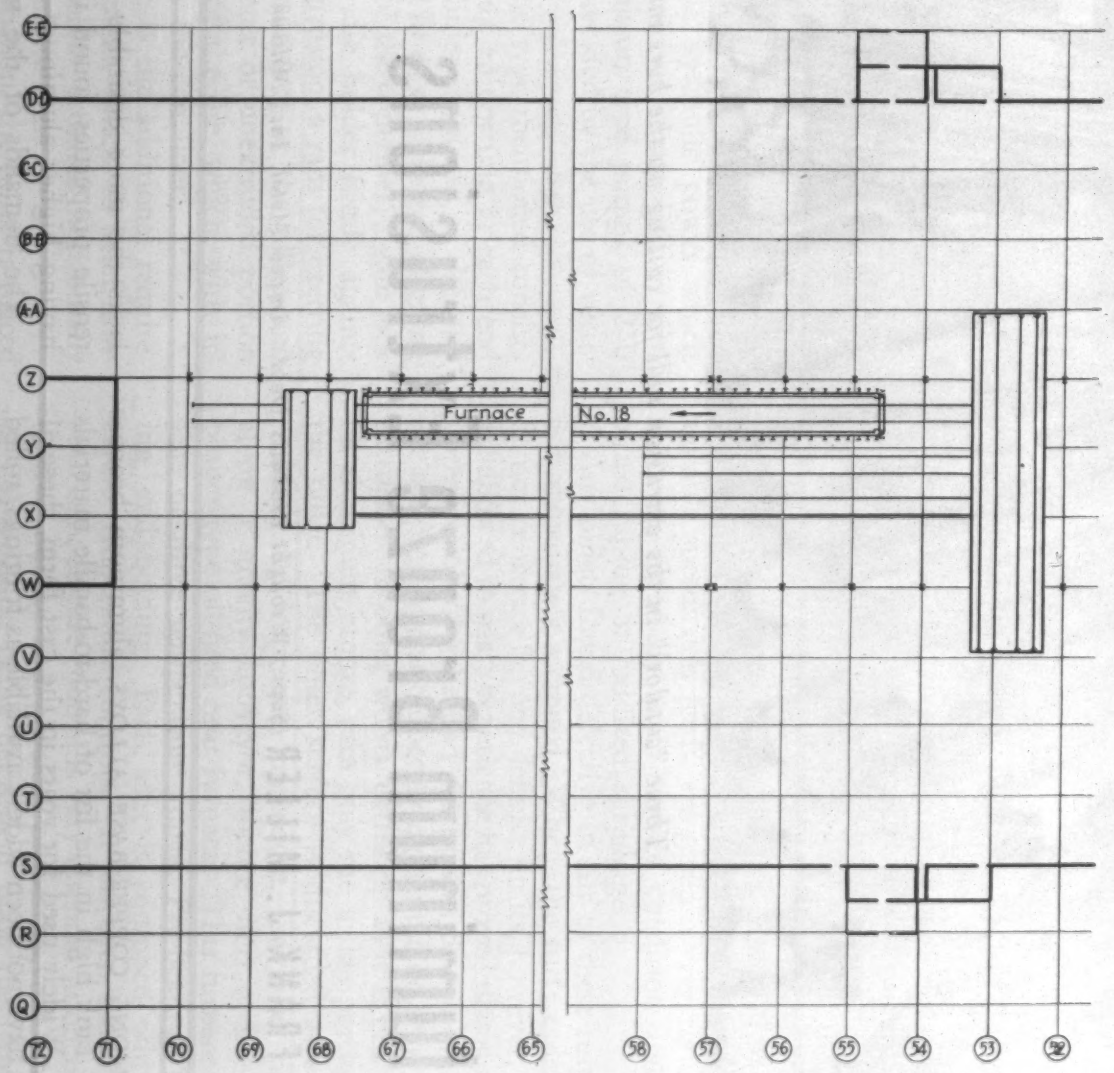
There is another group of 2 smaller furnaces, Nos. 13 and 14, similar in most details to the main body of units but batch loaded for experimental and special production under conventional program heat control.

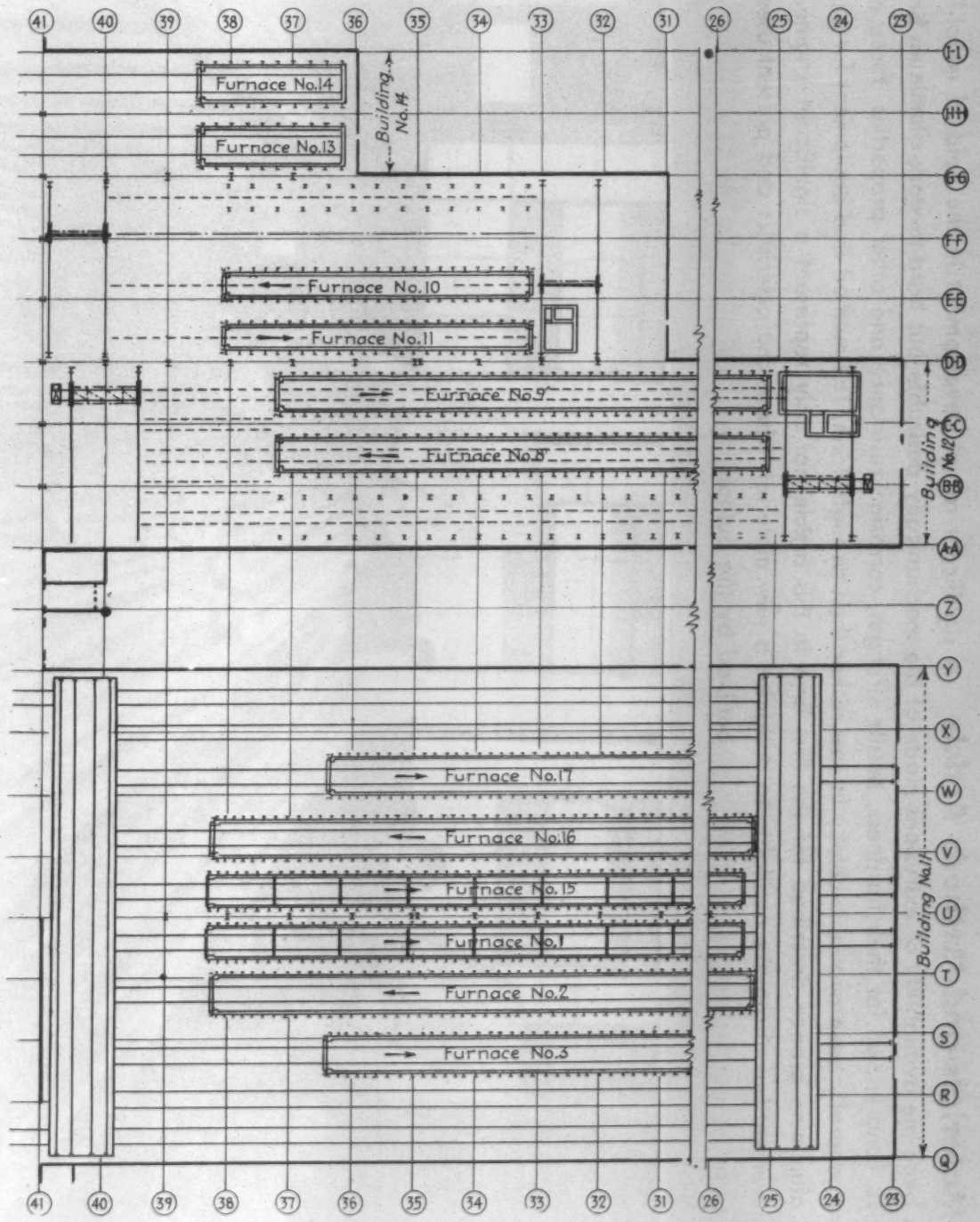
The drawings and the illustrations give a fair idea of the scope of this engineering accomplishment. The plant, while it operated, was definitely successful and and is one of the largest ever constructed. It demonstrated the efficiency and importance of comparatively new techniques on the heat treatment of steel castings—particularly the liquid quench and draw—a technique which bestows on the steel properties not approached by conventional methods. It is a heat treatment technique which has great possibilities in the post-war period.



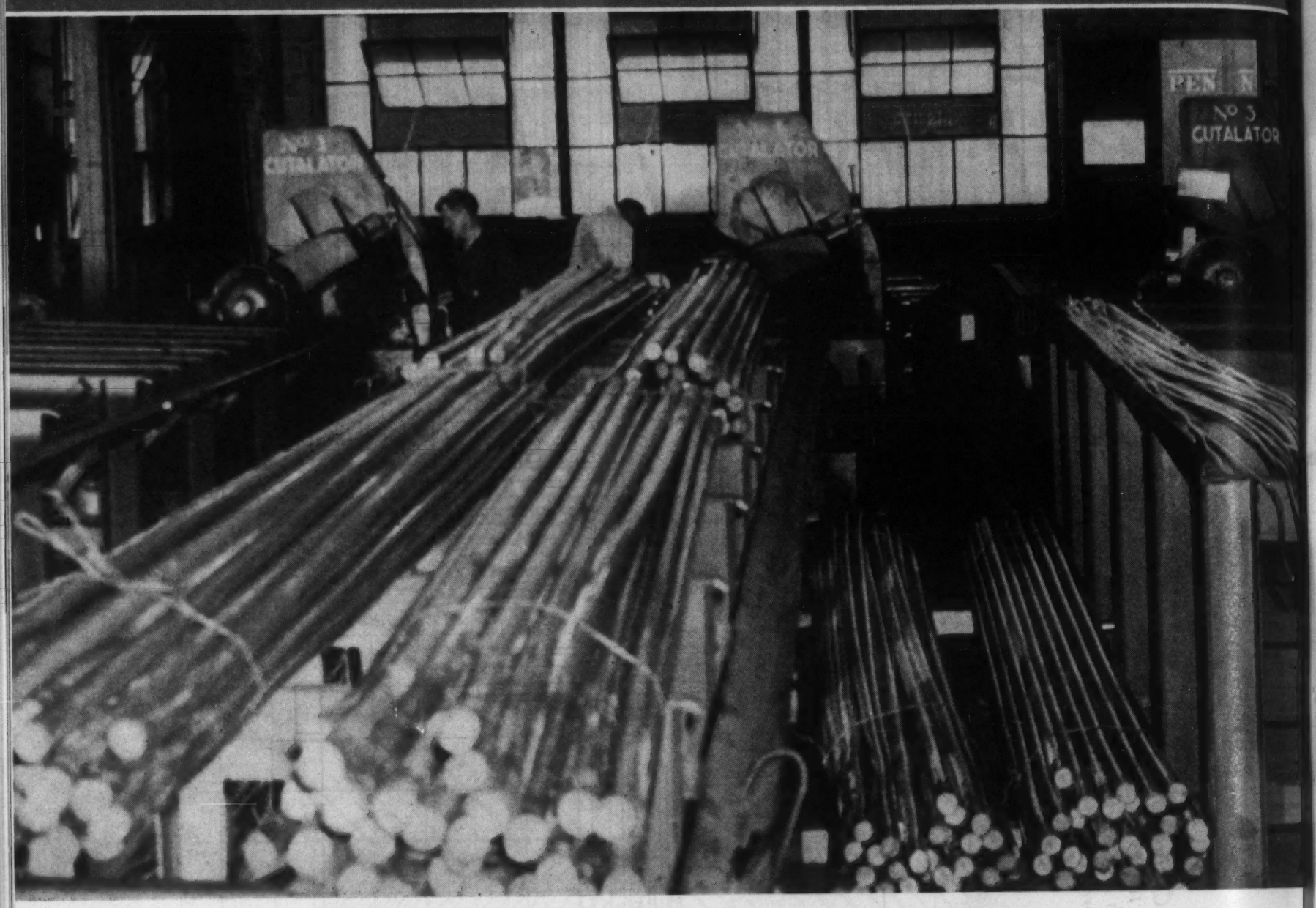
Schematic diagram of one of the ceramic radiant-type burners that make possible the high-speed heating achieved.

Condensed layout of the heat treating plant. Castings start at Nos. 1 and 15, leave Nos. 3 and 17, and are put through 8 and 9 if hulls or 10 and 11 if turrets, finishing through No. 18 if stress relief is required. Nos. 13 and 14 are special-production or experimental units.





A Materials-and-Methods Article A significant recent development in the field of metal-forms has been the availability of extrusions made of the mechanically desirable but hard-to-work aluminum bronze alloys. Long known for their hardness, tensile strength, corrosion resistance and other properties, these alloys have generally been available chiefly in cast rather than wrought form. The method and equipment for extruding aluminum bronze described for the first time in this article not only represent a significant engineering achievement but also make available to designers a new material, whose characteristics and present uses are outlined by the author.



Three "cutalors" in the extrusion mill for cutting up the bars into billets.

Aluminum Bronze Extrusions

by **FRANK J. MILLER** *Supt., Wrought Products Dept., Ampco Metal, Inc., Milwaukee, Wis.*

AMONG COPPER-BASE ALLOYS, aluminum bronzes rank high in the list of hard-to-handle materials. Widely used for years in the cast form, these alloys have not been widely available as forgings, rolled, or extruded engineering materials. Such production as there has been, has been largely confined to the alphatype, or low-aluminum content, bronze which lacks the more desirable attributes of hardness and tensile properties found in those aluminum bronzes having higher aluminum and iron contents.

The demands of the war effort in the past few years, however, have given great impetus to the use of extruded aluminum bronzes by the aircraft industry. The wearability and bearing qualities of these

alloys have long been recognized. The extrusion process has further increased physical properties to such an extent that aluminum bronzes now find increasingly wide usage in those applications requiring high strength, hardness, and bearing qualities.

The special type of aluminum bronze known as the high-iron, high-aluminum type, as partially specified by Federal Specifications QQB-666, Aircraft Material Specification 4635, and Air Corps An-B-16, ranging from 2.50 to 5% Fe and from 8.5 to 15% Al has responded very well to fabrication by extrusion. Extruded aluminum bronzes of this type are widely used as aircraft engine parts, landing gear parts, and controllable or variable pitch propeller parts, as well as in other industrial applications requiring the high physical properties found in this type of material. Extruded aluminum bronzes of a modified type, as specified by Aircraft Material Specification 4640, containing up to 6% Ni, have also been used in applications requiring extra high tensile and yield strengths, with Brinell hardness of approximately 200 under 3000 kg., and elongation of from 3 to 10%. The more common low-iron types, characterized by Aircraft Material Specifications 4630 and 4632, also find frequent application.

Extrusion Processes

The extrusion equipment, located at the Wrought Products Div. of Ampco Metal, Inc., for this type of fabrication is built around a hydraulic horizontal type Schloemann Press, having a capacity of 2,275 tons total pressure on the main ram and further equipped for tube extrusion with piercer attachment of 275 tons. This equipment has been found very adequate for the successful fabrication of all the alloys of the aluminum bronze group as mentioned above.

There is flexibility of such a nature that production is realized on any rod, shape, or tube in sizes normal to either a 7-in. or an 8¼-in. diam. container, both of which are available and readily interchanged, depending upon billet diameter deemed advisable for the job at hand. The hydraulic power which activates the ram and accessories is supplied by two Worthington horizontal piston type pumps of 250 h.p. each, pulsation being avoided by the use of vertical accumulators.

In essence, a press of the type mentioned consists of a ram, a container having an opening at each end and into which the hot billet is placed, a die and holder which has a tapered fit so as to be self-aligning when seated into one end of the container, a gate lock which holds the die and die holder firmly against the pressure attained in extrusion, a ram for exerting the pressure against the rear face of the billet, and a shear for severing the butt or unextruded portion of the billet, at the face of the die, which, with its holder, is retractable from the container.

In tube extrusion, there is the additional requirement of a piercing attachment, which, in brief, consists of a mandrel and holder actuated horizontally and centrally through a hollow ram.

During this type of extrusion, the billet is placed in the container against the face of the die, the ram remains stationary sealing the rear of the container, while the mandrel pierces the center of the billet; it ejects, through the die, a cylindrical slug of metal of a size dependent upon the diameter of the tools and the techniques of production. After the slug has been ejected, the mandrel continues to advance along with the ram, the ram pressure causing extrusion while the mandrel and the die form the tubular inside and outside diameters respectively.

This is not the only method used in tube extrusion, although it is the one found readily adaptable to the aluminum bronzes. Regardless of the method of tube extrusion, however, press alignment is of utmost importance and constant vigilance is necessary to maintain this requirement. If parts such as tool container, wear plates, guide keys, ram slippers, pressure ring or column nuts are found worn or defective, they must be corrected or high scrap will ensue. Container liners are generally replaced after usage has caused wear to an extent of 1/16 to ⅛ in. on diameters.

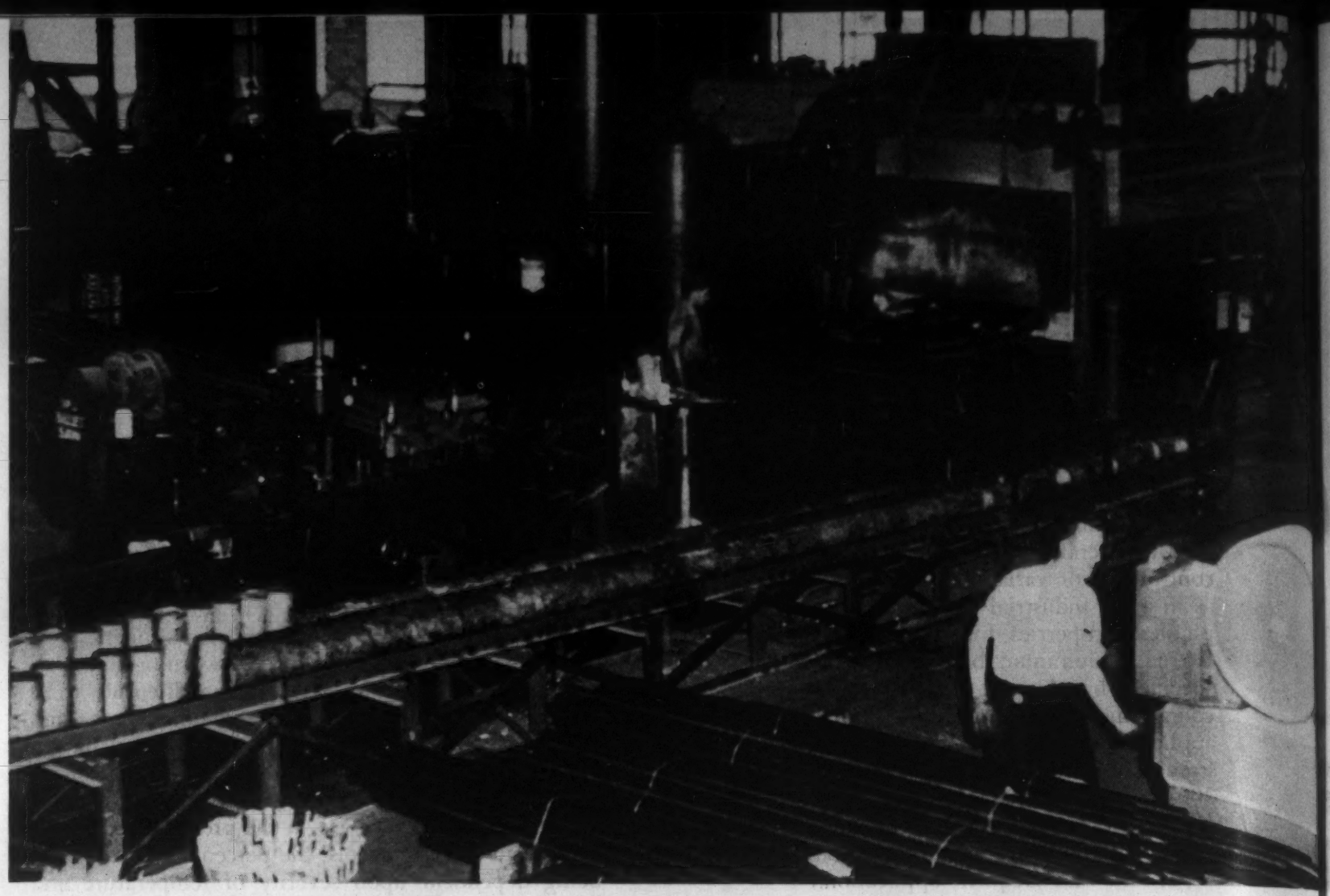
It is probably well to mention that tool steels of the tungsten alloy type are, at the present time, specified for all extrusion tools; the percentage of tungsten being dependent upon severity of temperature and pressure. In most cases, the dies are of 10% W alloy and are designed in such a manner as to present a narrow bearing, a bell shaped orifice, and a slight taper blending throat or orifice to the bearing.

Operating Details

Probably the easiest method of visualizing the entire extrusion process is by mentally following the sequence of operation from a billet through to the finished product. In an operation of this nature, it is well to keep in mind the analogy comparing billet condition to heredity and extrusion techniques to environment, each being as important as in the pattern of human behavior. For this reason, the billets, after being trimmed to length on a Motch & Merryweather cold-cutting, inserted tooth, circular saw of variable speeds and feeds, are given a very rigid inspection, especially as to surface condition and internal piping or oxidized shrinkage.

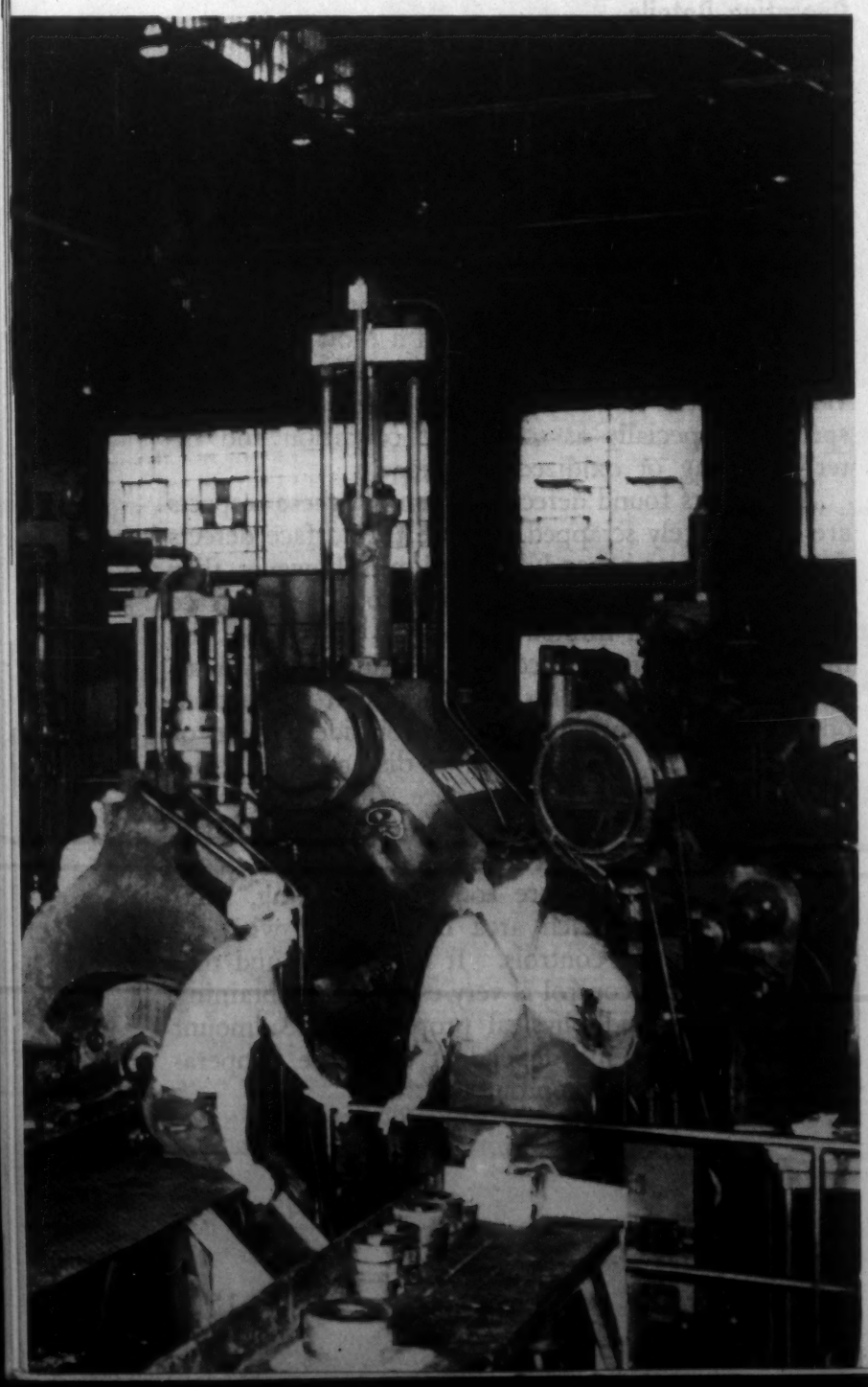
Any billets found defective in any of these respects are immediately scrapped. Where the surface defects do not penetrate beyond definite limits, however, they are allowed to pass; experience has proved that surface imperfection of a limited extent will be removed by the scalping operation occurring simultaneously with extrusion. In other words, extrusion as it is practised on aluminum bronze, uses only the inside portion of the billet. The outer surface is discarded as scrap.

After the inspection procedure, the billet passes along a gravity conveyor, thence into a five-pass pusher type oil-fired heat furnace. This furnace consists of three temperature zones: Pre-heating, heating, and holding. Each area is equipped with accurate temperature controls. It has been found that such temperature control is very essential in obtaining desired quality and physical properties, the amount of hot working being dependent upon the temperature and die area and contour.



The billet conveyor for transferring the billets to the heat furnace in the background.

One of the large extrusion presses.



Normally the aluminum bronze billets should be extruded at as low a temperature as possible, consistent with maximum pressure capacity. If this factor is not controlled, high billet temperature will result in excessive grain size as well as surface defects such as blisters, shearing, etc. Billet extrusion temperatures are not the same for all types of aluminum bronze, depending on the aluminum and iron contents, as well as on the amounts of other fourth and fifth alloying elements.

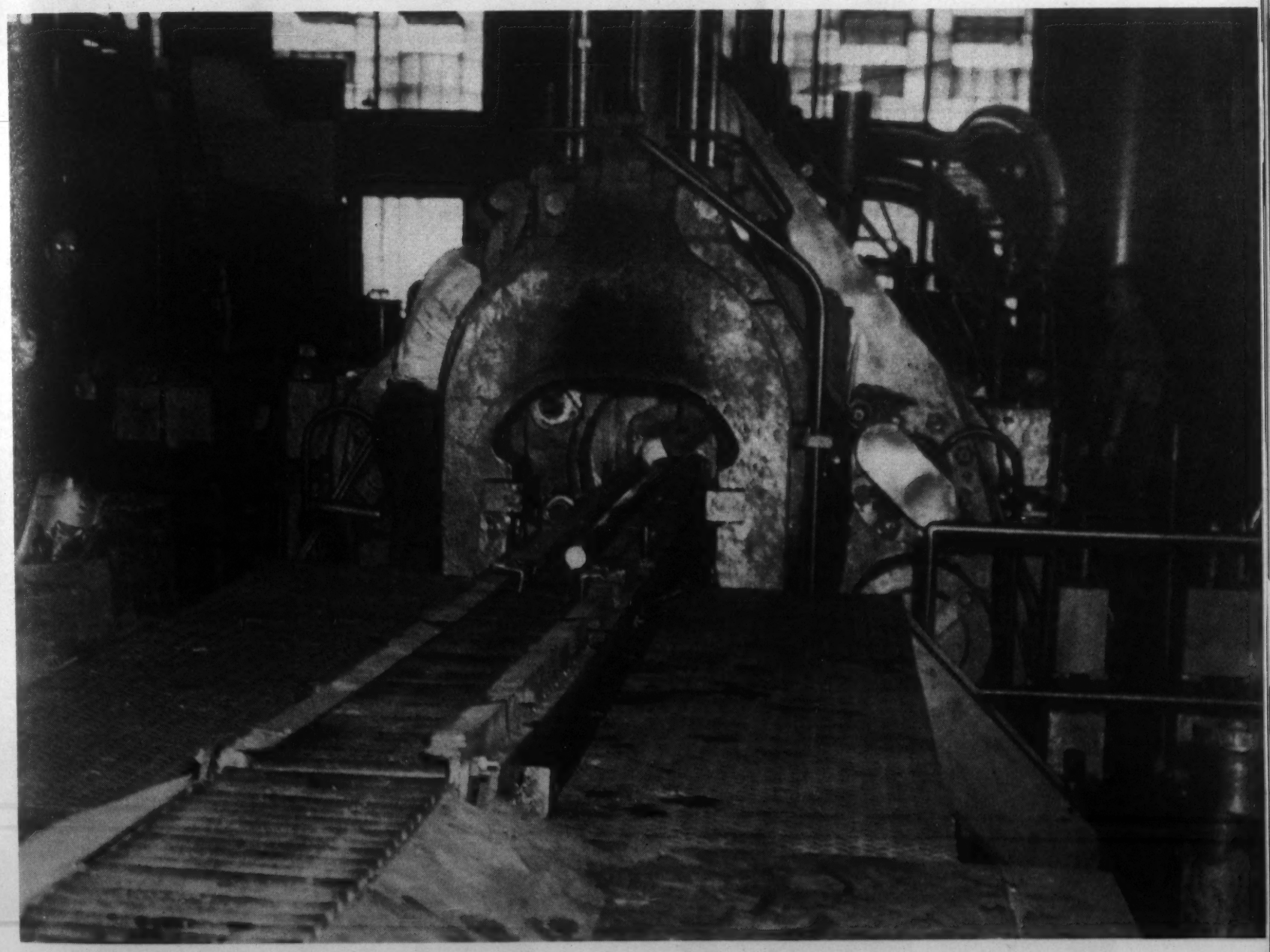
Upon leaving the furnace, of which the exit is as close as possible to the press so as to avoid loss of surface heat, the billet is rolled down a gravity conveyor to the ram side of the container as has been mentioned above. After insertion of the hot billet into the container, a die pressure disc or, as it is commonly called, a dummy block, is placed between the ram head and the billet. This block serves a dual purpose. It protects the ram itself from continued exposure to the relatively high billet temperatures, and it also serves as a scalping device, the dummy being 1/16 to ⅛-in. smaller on the diameter than the bore diameter of the container.

By using this device, there is assurance that the surface of the billet remains as a shell in the container after extrusion. This shell is subsequently removed by the forcing of an ejector disc through the container, the latter-named disc having a diameter approximately the same as the container.

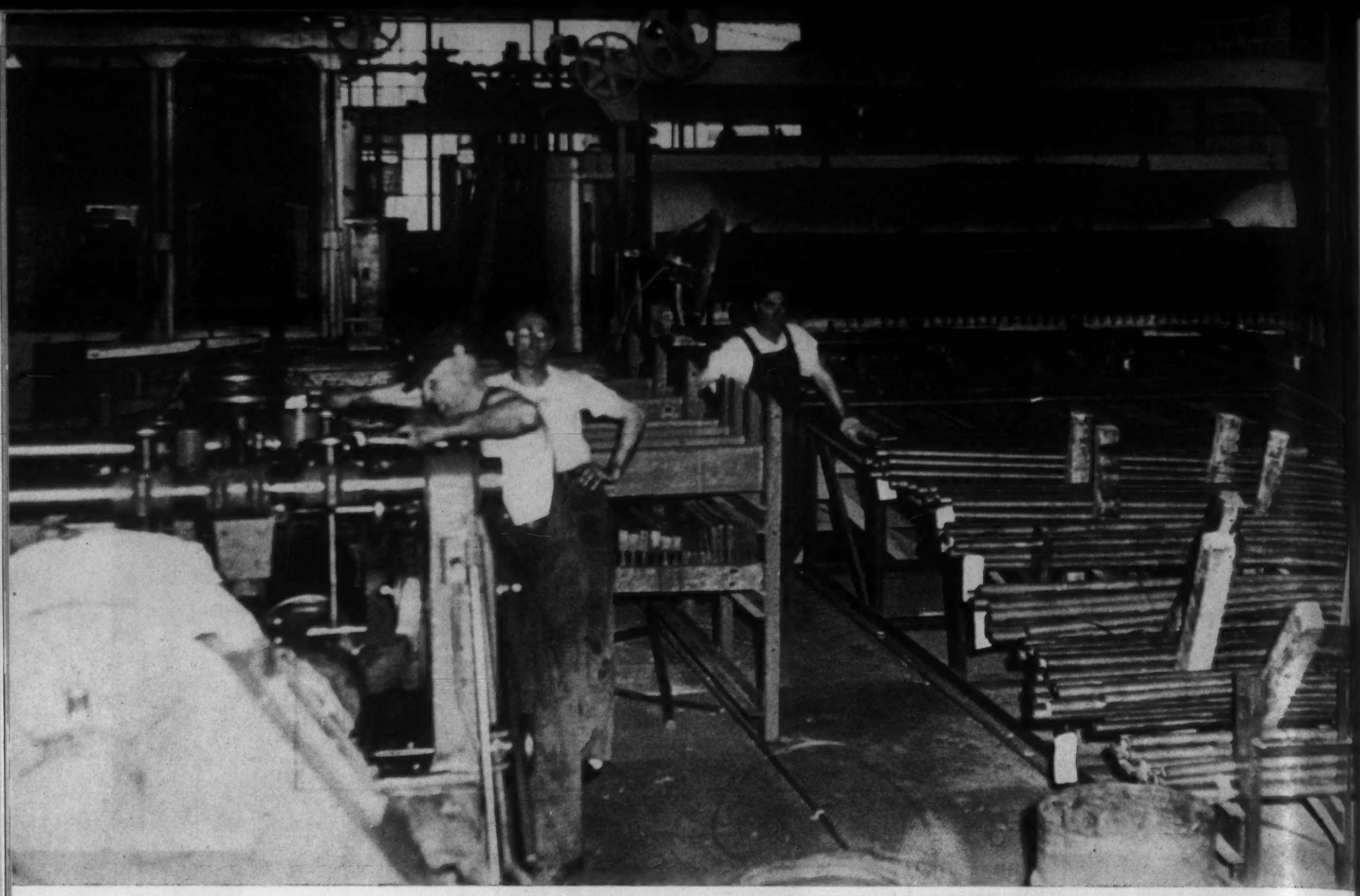
The full length of the billet is not utilized in extrusion, there being a residual amount of butt varying from 2 to 4 in. in length, such length being governed by the type of alloy and cross-sectional area of the product. This butt is severed from the bar at the face of the die as has been mentioned previously.

Table of Typical Aluminum Bronze, Sand Cast and Extruded

Nominal Analysis	2.75% Fe 8.5% Al Bal. Cu		3.25% Fe 9.5% Al Bal. Cu		3.50% Fe 10.75% Al Bal. Cu	
Form	*Sand Cast*	*Extruded*	*Sand Cast*	*Extruded*	*Sand Cast*	*Extruded*
Tensile strength, p.s.i.	75,000	82,000	78,000	88,000	90,000	95,000
Yield strength, p.s.i. (0.5% Extension)	28,000	37,500	29,500	40,000	37,000	47,000
% Elong. in 2 in.	40	25	20	20	14	12
% Reduc. of area	40	20	20	18	12	10
Brinell hardness, (3000 kg)	126	140	137	155	174	195
Specifications met	QQB-671a, Class A	QQB-666, Grade B Amendment 3		QQB-666, Grade B AMS-4635, 46-B17	QQB-671a, Class C	



An extrusion rod coming from one of the presses.



An annealing furnace with bar stock in the foreground.

One of the straighteners for straightening the product.

Inspection and Heat Treatment

After the extruded product has cooled sufficiently to enable ease of handling, it is subjected to a very rigid inspection, one phase of which is known in the trade as a nick and break test. This consists in fracturing the rear portion of the bar, exposing faulty grain size and other defects common to extrusion. Under controlled operations, these defects will invariably appear in the last portions of the extruded product. If, beyond this first break, defects remain apparent, additional fractures are made until such defects are eliminated.

The remaining quality bars are then trimmed to mill length by the use of either production hack saws or abrasive type circular saws. The latter named facilities must be used in the trimming of certain of the harder aluminum bronzes.

With only a few exceptions, all alloys are normally given a full anneal by passing through a continuous-type gas-fired furnace with controlled cooling at the exit end. We have found that such an anneal is highly important in the attainment of consistent physical properties even though these are sometimes later induced by cold working.

After annealing, the subsequent operations are dependent upon the quality of production desired. At the Ampco mill, there is what is called Class A and Class B rod, the former being held to very close tolerances and other requirements as outlined in the several federal and customer specifications, while the latter is considered as forging stock with less rigid dimensional specifications. In this article we will discuss in brief the Class A product; the only difference between it and Class B being the number of operations to which this class is subjected in the finished processing.

Following the nick and break inspection, the Class A bars are cold-pointed in a rotary cutter and then subjected to a pickling treatment which removes hard oxides and grit. The pickling solution and time of exposure depend upon the alloy in question. The pickled bar or tube is then cold-drawn to specified size and physical requirements. Usually there is a camber produced upon drawing, which is later removed by passing through an angular-roll-type Medart straightener. This being a final operation, the product is delivered to the inspection and shipping departments.

Extrusions and Sand Castings Compared

The entire manufacturing procedure is directed towards one end, namely, to produce a high-quality, high-strength product of which typical properties are shown in the Table along with the physical properties of sand cast material of similar analysis.

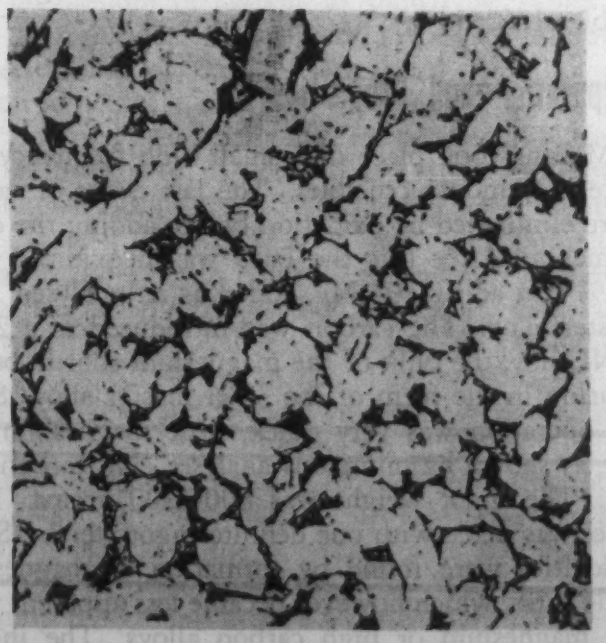
The comparison of the sand cast material with the extruded product reveals the advantage of extruded product as far as physical properties are concerned.

The micrographs show the difference in microstructure between sand cast material and extruded rod of the 3.25% Fe, 9.5% Al, balance copper type. Both photomicrographs are of 1 in. diam. material.

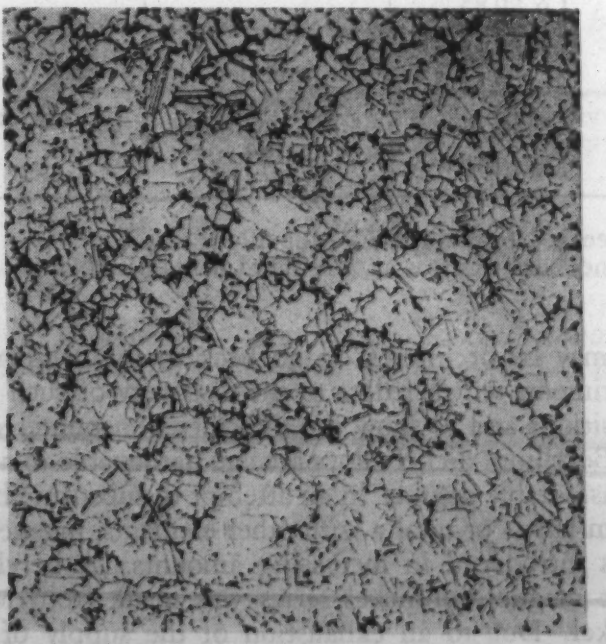
In conclusion, it should be noted that practically all of the difficulties ordinarily encountered in extrusion are not only present in the extrusion of aluminum bronzes, but are magnified to a greater or lesser degree depending upon the nature of the difficulty. Constant vigilance, together with the highest engineering skills and continuing development, must be exercised at all times to maintain a constant flow of uniform production.

This is particularly true at shops like the Ampco Wrought Products Div. where production is considered to be of a jobbing nature, which involves experience and equipment of sufficient flexibility to enable the fabrication of a host of alloys for specific industrial applications.

The "know-how" gained in the extrusion of millions of pounds of aluminum bronze has solved a multitude of problems, each being peculiar to the particular alloy under consideration, although, as in other industries, it is usually found that new problems have basic solutions in similar problems previously encountered with other alloys.



Microstructure of sand cast alloy, 3.25% Fe, 9.5% Al, balance Cu. 100 X.



Microstructure of extruded alloy of same composition. 100 X.

A Materials Article A significant materials-engineering development of recent years has been the growing interest in and use of heat-treatable nonferrous alloys like beryllium-copper and "Z-Nickel" for springs and similar applications. Information on the composition and general age-hardening behavior of the nickel-base alloys is presented for the first time in this report by Mr. Kroll of his original development work.

Heat-Treatable Nickel Alloys

by W. J. KROLL

Consulting Metallurgist, Niagara Falls, N. Y.

THE KNOWLEDGE that nickel-magnesium-carbon alloy combinations are age hardenable was introduced in this country about 12 yr. ago by the author, who disclosed the facts to the leading nickel company and demonstrated a rolled sample of the alloy. No publications about these compositions have appeared in American technical papers, except for the acknowledgment of the age-hardening properties by Merica[1]. The matter has been described more elaborately in the foreign literature[2, 3]. Two American patents concern this subject[4, 5]. An alloy bearing the name Z-Nickel is sold in this country mainly for use as springs, where good corrosion properties are important. According to an analysis, this alloy contains:

Composition, %	*Treatment*	*Hardness*
Ni 97.90 Ti 0.33 Co 0.85 Mn 0.17 Si 0.13 C 0.26 Mg 0.30	Quenched from 1100 C. (2010 F.)	166 Brinell
	Annealed afterwards at 500 C. (930 F.) for 14 hrs.	335 Brinell

Quenched from 1100 C.—166 BN
Annealed afterwards at 500 C., 14 hr.—335 BN

It may be of interest to go back to the original experiments which led us to the discovery of such compositions and to show the difficulties encountered.

Beryllium-nickel alloys are age hardenable to a very considerable degree. In an attempt to substitute beryllium partly or totally with other elements, magnesium was introduced in increasing amounts. A beryllium free magnesium-nickel series was made from Mond nickel. Due to an exhaustion of the supply of this kind of nickel, some alloys had to be made from rolled nickel obtained from France. While the melts made from Mond nickel did not show any aging, the French material hardened very considerably. This alloy, which later was shown in this country, was found to contain by analysis:

	Per cent		Per cent
Ni	96.80	Al	0.04
Si	0.16	Mn	0.02
Cu	0.31	Ca	0.018
Pb	0.016	Co	0.69
Sb	0.009	Mg	0.18
As	0.012	C	0.20

The Brinell hardness obtained with this composition after aging was 300 B.N. While the impurities Si, Cu, Pb, Sb, As, Al, Mn, Ca and Co were considered as normal, the presence of fairly large amounts of carbon and magnesium seemed suspicious. Therefore two series of alloys were made from Mond nickel, which contained 0.05% C and increasing amounts of carbon or magnesium alternatively. Neither the carbon nor the magnesium series showed appreciable aging. However a combination of carbon and magnesium brought about a very considerable age-hardening effect. This will be discussed in more detail later on. The results of these series are given in Tables 1, 2 and 3.

Preparation and Properties

Melting took place in a small high frequency furnace in alundum crucibles. The last traces of carbon were eliminated by oxidation before adding the other elements. After this the bath was deoxidized with 0.3% Mn and 0.1% Mg, added as an analysed 30% master alloy. The carbon was introduced as a 2.2% C-Ni alloy, the bulk of the magnesium shortly before pouring in the form of the 30% master alloy. Since the operation was very quick, little magnesium was lost, as shown by numerous analyses. No carbon was lost. The ingot weight was 800-1200 grams. Each series was made with one definite ingot weight. Some difficulties were found by formation of magnesium oxide skins, which however became less apparent with low magnesium or high carbon alloys. The ingots, which were about 1½ in. sq., were rolled to about ⅝ in. sq., to determine the hardness (500 kg. load, 10 mm. ball, 1 min.) or to wire and sheet to check the mechanical properties. A gas-fired furnace was

used for annealing, which permitted operation in the absence of oxygen.

Malleability: Nickel-carbon alloys with up to 2.19% C could readily be rolled. Nickel-magnesium alloys with 1.1% Mg were still malleable, but started cracking above this content of magnesium. Combinations of carbon plus magnesium were less malleable.

The reasons for this lack of malleability have been investigated. In general the magnesium bearing alloys have a tendency to transcrystallize. The long crystals show inverse segregation. Gases, if contained, concentrate along the greatly reduced crystal boundaries, causing weakness. By adjusting the pouring temperature, the temperature and weight of the mold and by bottom casting, transcrystallization has been overcome, at least for small ingots. The alloy composition has a considerable influence on the malleability. High carbon contents embrittle, if much magnesium is present. Nucleus forming agents, like titanium, which produces titanium carbide, improve the malleability slightly. This will be shown later. Malleability is improved by annealing the ingots at about 1100 C. (2010 F.) for at least 6 hr. After the as cast structure has been broken down, no more difficulties are found in the rolling even of high alloyed compositions.

Hardness versus Composition: Carbon and magnesium affect the maximum hardness obtained after aging. This is shown in Table 6. A maximum hardness of 405 B.N. was obtained with an alloy containing 0.4% C and 0.6% Mg. With 0.2 to 0.3% C and 0.3 to 0.4% Mg a hardness of 330 to 350 Brinell is still obtainable, with increased malleability. None of these compositions reaches the hardness of beryllium-nickel, *i.e.* 550 to 600 Brinell for the 2.5% Be alloy.

Substitution of Other Elements for Carbon or Magnesium: Since the combination of carbon and magnesium causes the aging, it was thought that other elements might be substituted for anyone of these constituents. Tables 4 and 5 show the results obtained. No substitute for magnesium could be found nor could carbon be efficiently replaced. A weak aging was found with carbon-calcium and carbon-silicon combinations. Silicon itself produces aging but considerable amounts are required.

Titanium produces no effect in substitution for either magnesium or carbon, as shown by Tables 4 and 5. Its use has been suggested long ago to improve the malleability of nickel[6]. The solid solubility of titanium in nickel is 2.5% at 700 C. (1290 F.)[7] This is far beyond the amounts found in Z-Nickel. Titanium forms with carbon TiC, the most exothermic of all known carbides; TiC is evidently stable against nickel, as well as it is against iron. This property may be used for grain control. If titanium is added to a carbon bearing nickel alloy, the highly dispersed TiC, which is formed, acts as a nucleus-producing agent. With 0.33% Ti in the alloy, only 0.08% C is tied up as TiC and withdrawn from age hardening. With 0.26% C in the alloy, of which 0.08% is tied up with Ti, there remains 0.18% C for aging purposes, which, together with 0.30% Mg permit, according to Table 4, the obtaining of a hardness of about 330 Brinell. Since the dispersed TiC helps hardening the ground mass, a slightly higher hardness may be obtained. A number of carbide or silicide-forming elements act in the same way.

Heat Treatment and Structure

The rolled alloys were generally heated shortly to 1100 C. (2010 F.) and quenched, after which they were annealed for 24 hr. at 500 C. (930 F.). Since carbon and magnesium may burn out at the comparatively high solution treatment temperature, special care has to be taken to avoid contact with oxygen. The thermal treatment depends somewhat on the composition and improved results may be obtained by the methods used in beryllium-copper and duralumin hardening. The age-hardened nickel-magnesium-carbon alloys show under the microscope small black areas of a sorbitic structure.

Causes of the Age Hardening: According to Case[8] the solubility of carbon in nickel increases with rising temperature. Mishima[9] claims that 0.52% C is soluble in nickel at 1315 C. (2400 F.) against 0.1% at room temperature. The solubility of magnesium in nickel, according to Bachmetew[10] is less than 0.1% at 500 C. (930 F.). Nickel carbide is an unstable compound. Its presence in nickel has never been ascertained. Magnesium carbide, which can be prepared with acetylene, is even more unstable[11, 12]. It seems therefore that the only possible stable compound in the ternary equilibrium diagram Ni-Mg-C is $MgNi_2$. In the actual state of the investigation, no definite explanation can be given as to the causes of the aging. Whether carbon reduces the solubility of $MgNi_2$ in nickel, or whether this compound reduces the solubility of carbon has not been shown yet. This could be the subject of a very important and interesting X-ray study. Even very small amounts of carbon produce aging, if sufficient magnesium is present. An alloy with 0.09% C and 0.90% Mg aged up to 237 Brinell. This shows that even common nickel, if too thoroughly treated with magnesium, is susceptible to considerable age hardening, since traces of carbon are frequently present.

Magnesium-Carbon Monel Metal: Since copper does not participate in the aging, it acts only as a diluent. The maximum obtainable hardness is therefore a function of the copper content. The rolling is made more difficult, if large amounts of copper are present.

Table I—Nickel-carbon alloys, free of magnesium. Quenched from 1050 C. (1920 F.) annealed 20 hr. at 500 C. (930 F.)

No.	C %	Malleability	Hardenability
1.	0.60	good	No aging
2.	1.52	good	No aging
3.	2.07	good	No aging
4.	2.19	good	No aging

Table II—Nickel-magnesium alloys, free of carbon. Quenched from 1050 C. (1920 F.) annealed 20 hr. at 500 C. (930 F.)

No.	Mg %	Malleability	Hardenability
1.	0.39	good	No aging
2.	0.70	good	No aging
3.	0.85	good	No aging
4.	0.94	good	No aging
5.	1.10	good	No aging
6.	1.36	bad	No aging
7.	1.80	not malleable	No aging

Mechanical Properties: As for almost all age-hardenable alloys, the tensile strength goes up considerably, while the elongation drops in the aged alloys. The following values were obtained for an alloy containing 0.68% Mg and 0.16 C:

Treatment	*Tensile Strength, p.s.i.*	*Elongation, %*	*Brinell Hardness*
Quenched from 1100 C. (2010 F.)	93,100	38.2	125
Annealed 20 hrs. at 500 C. (930 F.)	183,600	3.3	330

Conclusions

Nickel can be age hardened to a considerable extent by simultaneous additions of carbon and magnesium. No substitute for either magnesium or carbon could be found. A table showing the hardness values as a function of the carbon and magnesium contents is given. A maximum hardness of 405 B.N. was recorded with 0.4% C and 0.6% Mg.

Alloys with more than 1.1% Mg are hot short. Low magnesium contents are desirable, if good malleability is wanted. By sacrificing hardness for malleability, i.e. by reducing the magnesium content, alloy combinations can be produced, which still have a sufficient hardness for many purposes.

An alloy with 0.3% Mg and 0.2% C which is quite malleable, hardens up to 330 Brinell. Nucleus forming additions, like titanium, permit improvements in the malleability by control of the transcrystallization. However titanium ties up a little carbon, which is withdrawn from the aging; it does not replace either carbon or magnesium in their combination and hardens the ground mass slightly.

Since small amounts of carbon, even below 0.1%, cause pronounced age hardening in presence of a sufficient, but small amount of magnesium, great care has to be taken when deoxidizing nickel with this agent. A number of multi-element alloys containing magnesium plus carbon have been examined. Despite the fact that the nickel-magnesium-carbon alloys don't reach the high hardness values of nickel-beryllium alloys, they find actually considerable use as material for springs.

Table III—Nickel-magnesium-carbon alloys. Quenched from 1050 C. (1920 F.) annealed 20 hr. at 500 C. (930 F.)

No.	Mg %	C %	Quench hardness	Hardness as aged	Malle-ability
1.	0.50	0.24	120	190	good
2.	0.91	0.22	174	401	fair
3.	0.88	0.24	156	363	good
4.	1.10	0.27	156	363	difficult
5.	0.94	0.27	152	415	good
6.	1.12	0.19	159	388	fair
7.	0.65	0.26	131	197	good

Table IV—Substitution for carbon of other elements in the magnesium-nickel alloy. Quenched from 1050 C. (1920 F.), annealed 20 hr. at 500 C. (930 F.)

No.	Mg %	Other addition %	Quench hardness	Hardness as aged	Malle-ability
1.	0.7	1.0 B	104	110	Hot short
2.	0.7	2.7 Ti	110	114	Good
3.	0.7	27.0 Cu	107	107	Good
4.	0.7	1.0 Si	76	85	Hot short
5.	0.7	2.0 Sn	114	114	Hot short
6.	0.2	3.2 Zn	107	107	Good
7.	0.2	2.0 Al	———	No aging	Hot short
8.	1.2	1.6 Fe	———	No aging	Good
9.	1.2	1.6 Cu	———	No aging	Good
10.	1.2	2.0 Co	———	No aging	Good
11.	1.2	1.6 Si	———	No aging	Hot short

Table V—Substitution for magnesium of other elements in the nickel-carbon alloy. Quenched from 1050 C. (1920 F.) annealed 20 hr. at 500 C. (930 F.)

No.	C %	Addition %	Quench hardness	Hardness as aged	Malle-ability
1.	0.14	0.5 Si	———	No aging	Fair
2.	0.12	0.2 Be	———	No aging	Good
3.	0.12	0.2 Al	———	No aging	Good
4.	0.20	1.3 Ca	107	125	Good
5.	0.20	3.0 Ce	129	129	Good
6.	0.20	0.6 Be	138	138	Good
7.	0.20	3.0 Ti	125	129	Good
8.	0.20	2.0 Si	129	143	Good
9.	0.20	8.0 Zn	129	134	Hot short
10.	0.20	27.0 Cu	———	No aging	Hot short
11.	0.09	2.0 Sn	———	No aging	Good
12.	0.09	5.6 W	———	No aging	Good
13.	0.09	5.6 Cr	———	No aging	Good
14.	0.09	5.0 Fe	———	No aging	Good
15.	0.09	5.0 Co	———	No aging	Good

Table VI—Hardness as a function of magnesium and carbon content. Quenched from 1100 C. (2010 F.) annealed 24 hr. at 500 C. (930 F.)

	C, %							
Mg, %	0.07	0.10	0.15	0.20	0.30	0.40	0.60	0.90
0.0	100	104	108	110	120	125	125	130
0.1	110	130	160	200	210	250		
0.2	120	150	210	270	270	270	250	
0.3	135	190	260	330	330			
0.4	145	230	310	350	340	340		
0.5	160	270	320	360	360	340	375	
0.6	185	295	330	370	375	405		
0.7	220	305	330	370	375			
0.8	245	310	330	370	380	400	405	
0.9	270	315	330	370	380	400		
1.0	280	320	335	370	360	390	390	
1.1				340	330			

See Génie Civil[8]

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Cast Iron Thread Gages

by C. C. TAGGART *Production Engineer, Continental Gin Co., Birmingham, Ala.*

A Materials-and-Methods Article One of the war's worst production bottlenecks has been the supply of steel gages for dimensional inspection. The author's company solved the problem by using specially-processed high strength cast iron for thread gages, with notable savings in production time, operating costs, labor and critical material. In this article he describes the use and performance of the cast iron gages and some of the machining, heat-treating and other operations in their manufacture.

SINCE THE INTRODUCTION OF MASS PRODUCTION and interchangeability of parts in industry, gages have been an essential tool. The manufacture of gages has grown until in the present era it is an essential industry, and the materials and production methods used of major concern to many engineers.

Shortly after the beginning of World War II, the government called on American industry for a tremendous increase in the production of equipment and supplies for all the armed forces. This great increase in production and the conversion from peace time products to war matériel placed an enormous burden on the gage manufacturers.

As a result of this increasing burden, the gage manufacturers began to fall farther and farther behind in deliveries. This worked a hardship on industry as a whole in that gages became one of the bottlenecks in the manufacture of ordnance material.

When our company undertook the manufacture of war products under government contracts, we, too, were faced with this gage problem. In many instances gages became the essential item with the longest delivery promise.

The Overall Production Problem

Owing to the rigid inspection required by Ordnance, it is necessary in most cases to inspect parts produced for them one hundred per cent. Where threaded holes were concerned, we were immediately faced with a gage shortage. Parts were being produced at a very high rate of production. One hundred per cent inspection of these parts caused gages to wear beyond the usable stage in a very short time.

It was impossible to keep enough plug thread gages on hand to maintain our production rate. The management, when confronted with this problem, decided that we would make our own plug thread gages. To manufacture these plug thread gages, we were able to obtain through Army Ordnance a Jones & Lamson automatic thread grinding machine, illustrated in Fig. 1. Since we are a producer of Meehanite iron castings, our tool room is constantly searching for new applications and it was upon their recommendation that the use of this specially-processed high strength cast iron for plug thread gages was initiated.

In the conventional type of plug thread gage, the handle and gaging member are manufactured separately. This requires the fitting and assembly of the two component parts after each has been completely machined. The machining of the two parts requires different procedure and as a result two different series of production steps must be followed in their manufacture.

To overcome this situation, it was decided to produce a one-piece casting, with the handle and gage cast integral. The question of the number of patterns to cover a certain range of sizes was also considered. It was decided that 3 patterns would be sufficient to cover a range of 1¼ in. to 2¾ in. diam. gages (see Fig. 2.) This was possible because of the uniform structure of Meehanite castings throughout varying metal sections. With only three patterns to cover this range of gage sizes, we could still depend upon this material to produce a gage that would perform equally well regardless of size within this range.

As mentioned before, it is necessary on certain items produced on Ordnance contracts to make one hundred per cent inspection in order to meet the Ordnance Specifications—one such item for example is the head for the fragmentation bomb we are manufacturing for Army Ordnance.

This head was originally designed to be made as a steel casting. Later, material alternates were added, allowing the part to be made as a steel forging, a steel stamping or a malleable iron casting. Most of these materials are critical. Through the joint efforts

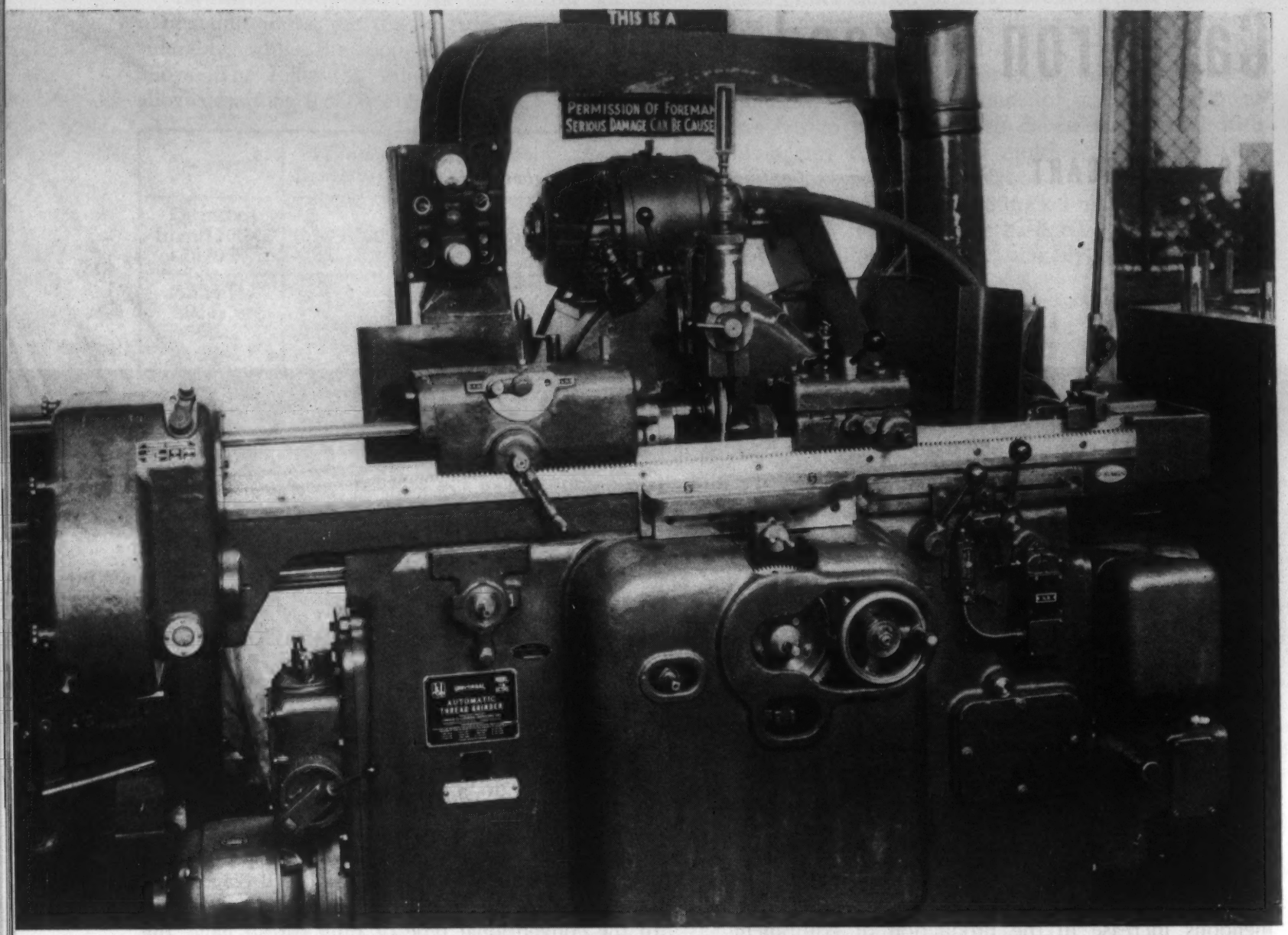


Fig. 1. Jones & Lamson automatic thread grinding machine used in the production of cast iron thread gages.

of our company, the Meehanite Research Institute and the Birmingham Ordnance District of the War Department, the material specifications were revised to allow the use of high-strength iron castings as a replacement material for the head part. This released steel or malleable iron for other purposes.

The production rate of the Meehanite head and the base part made of malleable iron is 175,000 each per month.

Because of the short cycle of production on these two items, it became necessary for our Inspection Department to find some means of speeding up inspection. This was accomplished by the chief inspector through the use of a mechanical device which he designed and built, and which is shown in Fig. 3. The Meehanite thread gage was placed on the revolving shaft. When the part to be checked was held in position by hand, the thread gage was run in and then out of the part by the friction-driven power device. Gages used on this machine were worn beyond the usable stage in a very short time. Thus, it was necessary for a large number of gages to be kept on hand for use with this machine. It is evident that should it have been necessary to depend upon gage manufacturers for this particular gage, we would have been faced with a very serious problem.

The Meehanite gage being produced for use in our plant is easy to manufacture as well as economical. Cast irons of this type can be machined at a much faster rate than tool steel, hence the cast iron gages can be manufactured in less time than the gages made from tool steel. Not only are iron gages more economical to produce but by their use tool steel, always a critical material in wartime, is released for producing many other items for which it is needed.

The castings for the Meehanite plug thread gages are produced on squeezer-type molding machines, which give a high rate of production and hence a low molding cost. The plug thread gages are being cast of Type "GB" Meehanite, the mechanical properties of which are as follows:

Tensile strength	45,000 p.s.i.
Modulus of elasticity	19,000,000 p.s.i.
Transverse strength 1.2-in. bar—18-in. centers	
Load	3000-3400 lbs.
Deflection	0.28-0.34 in.
Compressive strength ...	160,000 p.s.i.
Fatigue strength	19,000 p.s.i.
Shear strength	44,000 p.s.i.
Brinell hardness (as-cast)	196

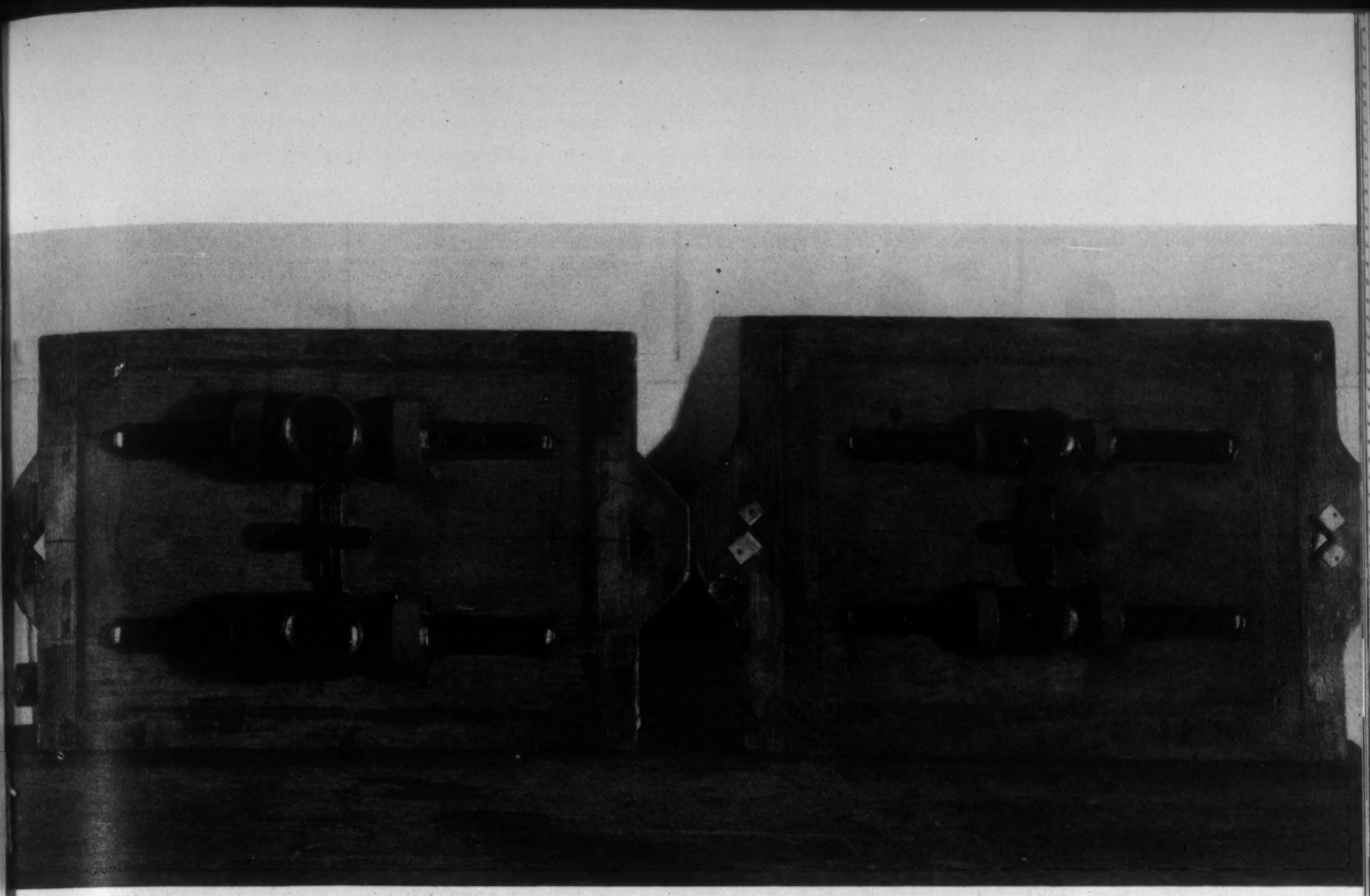


Fig. 2. Pattern set up to cover a range of 1¼ in. to 2¾ in. diameter gages.

Fig. 3. Specially designed testing device utilizing cast iron gages, permitting high speed thread gaging.

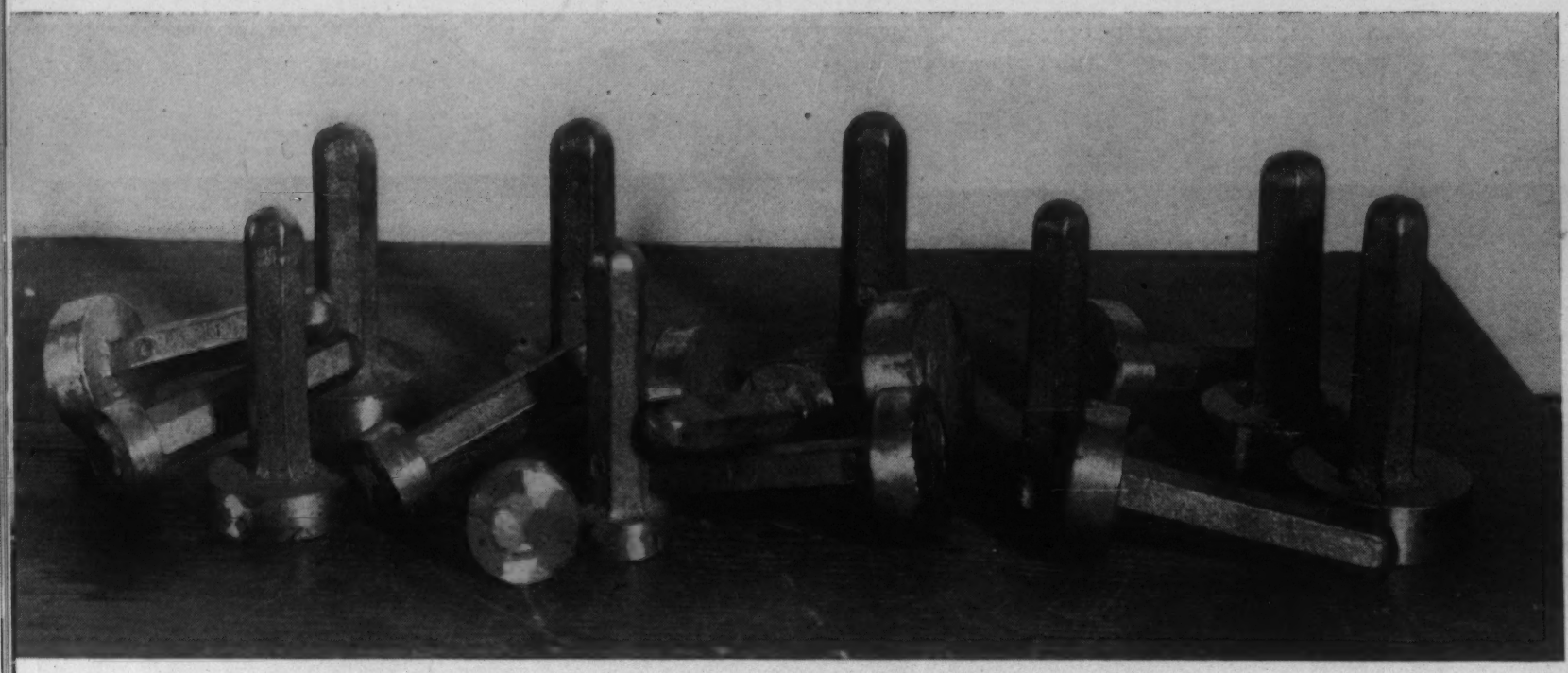


Fig. 4. Various rough gage castings.

Machining and Other Processing

After the rough castings are cleaned in the foundry (see Fig. 4) they are processed through the following operations:

1. Center both ends.
2. Rough turn and face ends.
3. Heat treat.
4. Lap centers.
5. Finish grind the major diameter.
6. Rough and finish grind the thread.
7. Grind flat on first thread and last thread.
8. Grind notch in gage.
9. Polish handle.
10. Stencil pertinent data on handle.

The following equipment is required to manufacture Meehanite plug thread gages:

1. Pattern equipment.
2. Squeezer molding machines.
3. Small lathes.
4. Production heat treating furnaces.
5. Center lapping machines.
6. Cylindrical grinders.
7. J. & L. thread grinders.
8. Small tool grinders.
9. Buffing or polishing wheels.

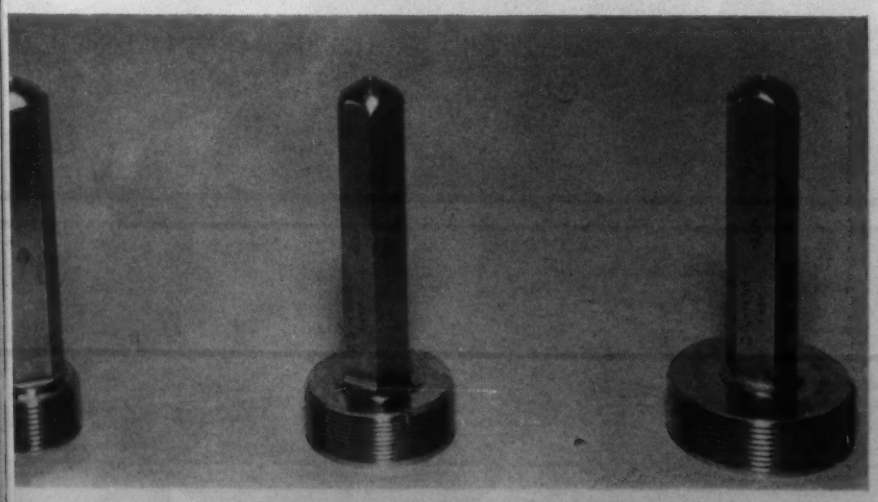


Fig. 5. Finished Meehanite thread gages.

The centering of both ends, the rough turning and facing operations are performed on lathes.

For heat treatment the gages are preheated to a temperature of 1200 F., then transferred to a high speed furnace and brought up to a temperature 1570 F. They are then quenched in cool oil. There is no drawing operation.

After heat treating, the centers are lapped on a center lapping machine. Next, the gages are finish ground to the major thread diam. on a cylindrical grinder.

They are then taken to the Jones & Lamson automatic thread grinder where the thread is rough and finish ground. This operation is completely automatic, once the machine is set up. After grinding the thread on the gage a flat is ground on the first thread and the last thread to eliminate the sharp edges at the thread runout.

In order to improve upon the appearance of the gage, the handle is rough ground and polished.

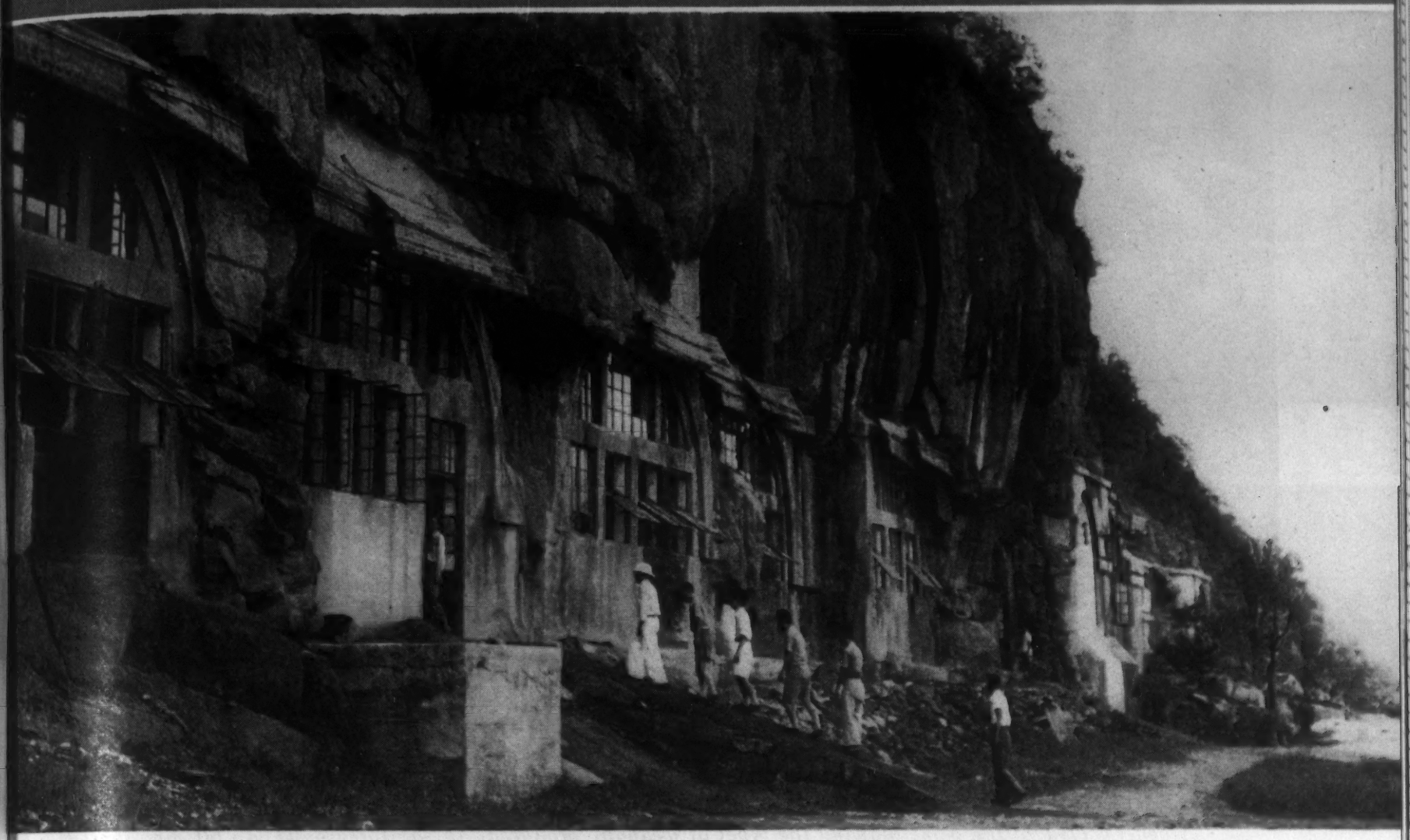
The last operation is to mark the gage with the pitch diameter and such other data as is necessary to identify it (see Fig. 5).

Advantages

These special cast iron gages being used in our shop have proved quite successful for both production and inspection purposes. They are economical in a number of ways. First, the time necessary to produce any gage is considerably less than the time required to obtain the gage from a gage manufacturer. Particularly is this true under present war time conditions. The machining characteristics of Meehanite make it easier and faster to machine than the tool steel conventionally used in thread gages. Next, the cost of iron castings is less than the cost of tool steel.

Finally, the most important economy is represented by the fact that Meehanite iron gages actually wear longer than do steel gages. This was apparent on the first application of the iron gages, and our extensive experience with them since indicates that they have up to 25% longer life than steel gages.

With Donald Nelson at this writing somewhere in China establishing a Chinese WPB, and the general problem of Chinese and American military and production cooperation currently outstanding, it is timely indeed to have these pictures revealing China's progress in metal-working and suggesting her needs and potentialities in this war-production field.



An exterior view of the munitions plant, located deep in a rock cave.

A Chinese Munitions Plant

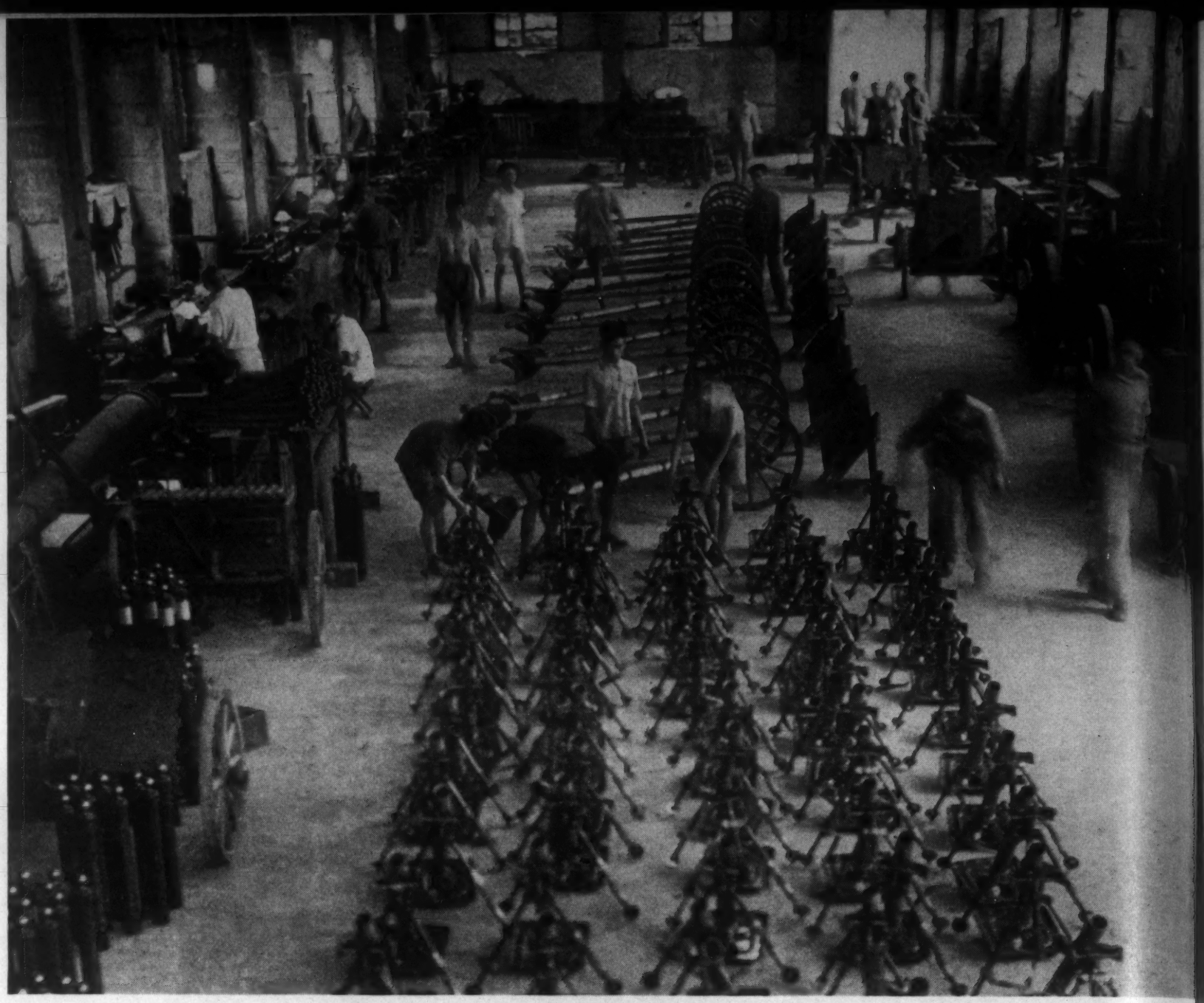
—A Pictorial Presentation

THE GALLANT RESISTANCE which the Republic of China has made against the unwarranted attacks by the Japanese army for over 7 years has awakened the admiration of the American people. Supplying the Chinese army with munitions and equipment has been a constant problem. It still is. One of the chief aims of the inter-allied High Command is to open the Burma Road or gain access to China in some other way so as to augment the sorely needed supplies of the army.

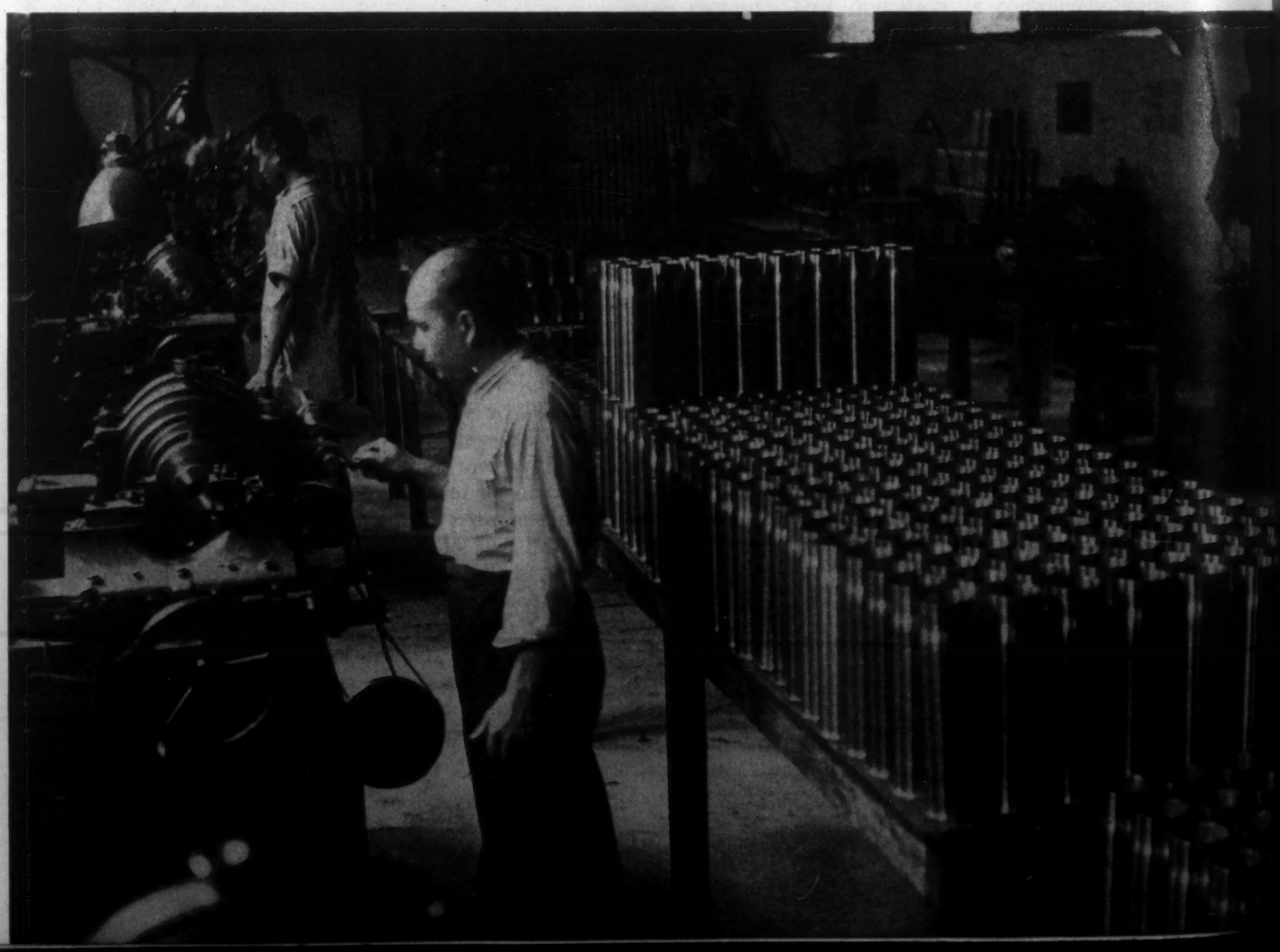
It is admitted that China herself could not and cannot produce enough ammunition and fighting equipment to fill her army's needs. Still her people and government have done some yeoman work in this field.

In our March 1944 issue we published a few pictures showing the general manufacturing problems faced by various Chinese industries. In this sequel we have singled out one metal-working plant and will present some views of its operations in the manufacture of several types of munitions. The location of this plant is not revealed but it is one that keeps a small part of the Chinese army supplied with weapons, shells, etc. This plant is located deep in a rock cave safe from enemy air attack, as shown above.

At this plant, as some of the pictures reveal, are produced 75 mm. anti-tank guns, 15 cm. heavy mortars, 60 mm. mortars, field guns, fuse parts, gun carriages, shell cases, etc. The captions tell the story of this interesting plant. —E. F. C.



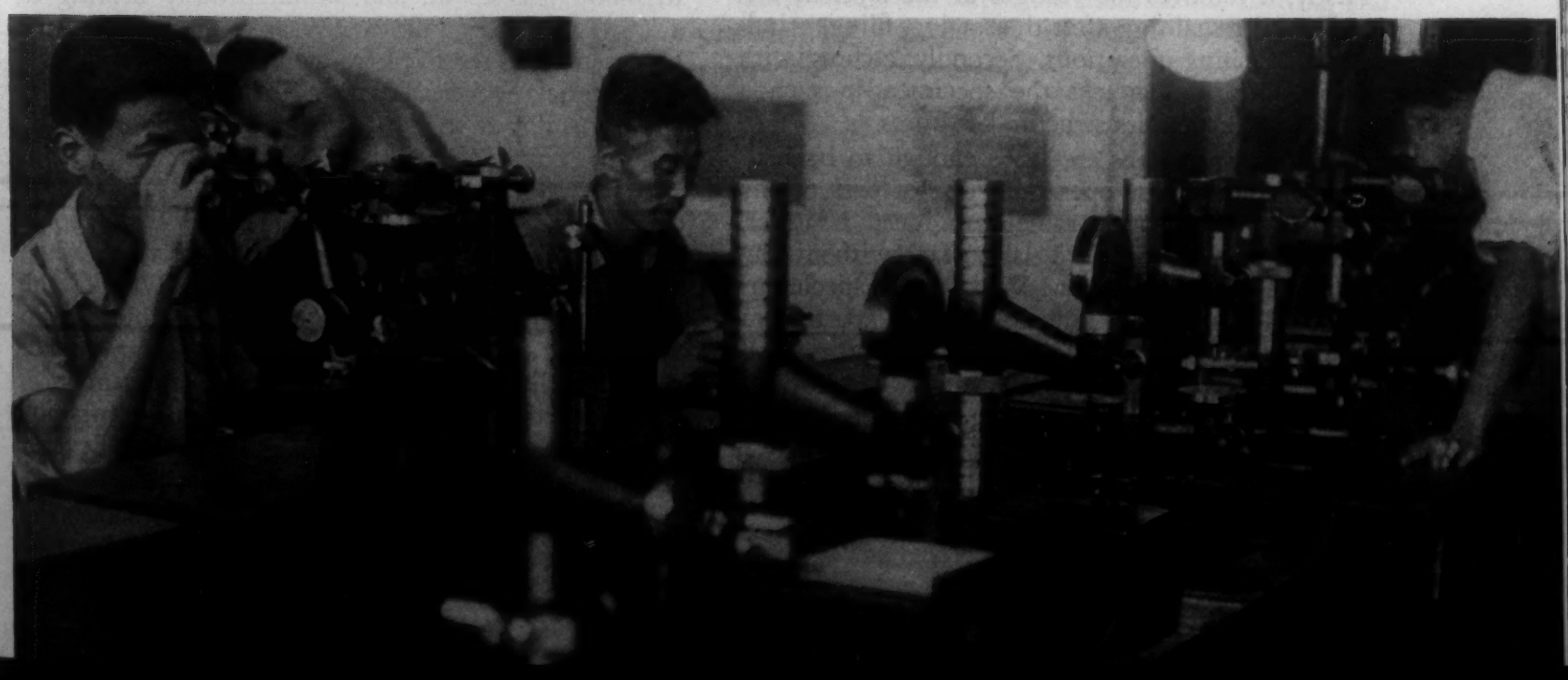
A general view of the plant showing the types of weapons produced. In the foreground are 60 mm. mortars, with anti-tank guns in the background.



Making shell cases for the 75 mm. guns.

Women workers making fuse parts.

Assembling gun carriages for the 75 mm. anti-tank gun.



Testing equipment for material inspection in the laboratory.

A Methods Article The metallographic microscope is the basic tool for quality control of those metal-working processes involving changes in the structure of the material. More efficient metallographic inspection is the chief aim and outcome of the new method of mounting microspecimens described by Mr. Hochschild in this article.

New Method of Mounting Metallographic Specimens

By ULRIC J. HOCHSCHILD *Metallographer, United States Metals Refining Co., Carteret, N. J.*

One of the most important tools of the metallographer is the microscope. The development of this instrument and other apparatus and material being used in conjunction with it have made great strides in recent years. Among those to be mentioned are better photomicrographic plates, improved illumination sources, such as the tungsten arc lamp, improvements of optical design, advances made in the use of polarized light, etc. All these improvements challenge the skill of the metallographer to make full use of their possibilities. The writer hopes that this article may be a small contribution to this end. Before describing any new methods let us review briefly the main objects of microscopic examination of specimens and some of the problems encountered.

The purpose of examining metal specimens under the microscope is to reveal their crystal structure, inclusions, voids, etc. A great deal of preparation of the specimen is necessary. The surface to be examined must for optical reasons be flat and is therefore filed, ground on several grades of emery wheels or emery papers, and polished on a revolving cloth covered disc. This is usually followed by some chemical etching method which serves either or both of the following purposes.

Firstly, it removes the vestiges of the layer of distorted metal remaining after the sawing, filing, grinding and polishing operations. Secondly, etching with a suitable medium attacks the specimen in such a manner as to reveal its structural features.

When the specimens are large enough to be handled comfortably these operations do not present any great difficulties. Considerable care must, however, be exercised in preserving a flat surface without any rounding off on the edges. With small specimens this becomes practically impossible quite apart from the difficulties encountered in holding such a small sample against a grinding or polishing wheel revolving at comparatively great speed. Heat created by friction is an additional source of discomfort.

Commonly Employed Mounting Methods

In order to solve the above mentioned problems it is modern practice to embed metallographic specimens in some plastic material, which, when duly processed, becomes hard and impervious to chemical solutions used in etching. The most popular and best method is that of mounting with the aid of a hydraulic press. The plastic used may be opaque or transparent, as illustrated by Fig. 1. The molding of the mounts is done in the following manner.

The specimen surface to be examined under the microscope is filed flat. Then the specimen is laid with its roughly prepared surface downward onto the bottom plate of the mold assembly (see Fig. 2). The cylinder is then placed over this plate and the space around and above is filled with mounting powder, the amount of which was measured and depends on the desired height of the finished mount and the amount of compression of the plastic during molding. Then the piston is inserted and the whole enveloped with an electric heating jacket and placed into the hydraulic press. The mounting powder may either be thermosetting or thermoplastic. Thermosetting material as, for instance, "Bakelite" (opaque) is hardened by compressing with a pressure of 3,000 to 4,000 lbs./sq. in. and simultaneously heating to 120 to 140 C. (250 to 280 F.), after which the mount may be removed from the press. Thermoplastic material, such as "Transoptic" mounting powder —(furnishing a transparent mount as illustrated by Figure 1(b) is heated to 120 to 140 C. (250 to 280 F.) under simultaneously applied light pressure of about 200 to 500 lbs./sq. in., and then cooled under a pressure of about 4,000 lbs./sq. in. When the temperature has dropped to 80 C. (176 F.) the mount has become hard and may be removed from the mold. Thereafter the mounted samples are ground, polished and etched in the usual manner.

The practice of mounting eliminates the problems described in the early part of this article. Several

specimens may be mounted together in one mount. This is a time-saving factor, and furthermore, facilitates comparison between the specimens in the mount; all of which will, after grinding and polishing, in this way receive identical etching treatment.

The New Method

There remains however, one difficulty. When a number of small specimens whose cross-sections are to be examined, such as pieces of wire, are mounted together in one mount, difficulties are encountered in keeping the specimens in their proper positions. They would have to be wound with fine wire into a bundle in order to have them stand up on the bottom plate of the mold. This has to be done in such a manner that sufficient space remains between the individual samples in order not to distort their shape while molding.

In spite of all precautions taken, however, it will frequently happen that they fall over when the powder is filled into the mold or during the application of pressure. Should this be the case, it is sometimes possible to saw the mound in a manner to show the desired section of the specimens, providing that transparent material is used, since then all sides of the specimens are visible and the cut of the saw blade can be placed accordingly. With opaque material this method cannot be resorted to, and the specimens may be spoiled by a wrong saw cut.

To overcome this difficulty the following new mounting technique has been developed and successfully employed in our metallographic laboratory and is used for mounting specimens intended for mechanical polishing.

The new method is based on the fact that a thermosetting material once cured retains its hardness and shape when subjected to a second heating. A disc of such thermosetting material about ¼ to ½ in. thick is made in the mounting press in the usual manner, as previously described. This disc is drilled with holes slightly larger in diameter and shape than the specimens under examination and serves as a holder for them. This holder with its specimens is then placed onto the bottom plate of the mold as-

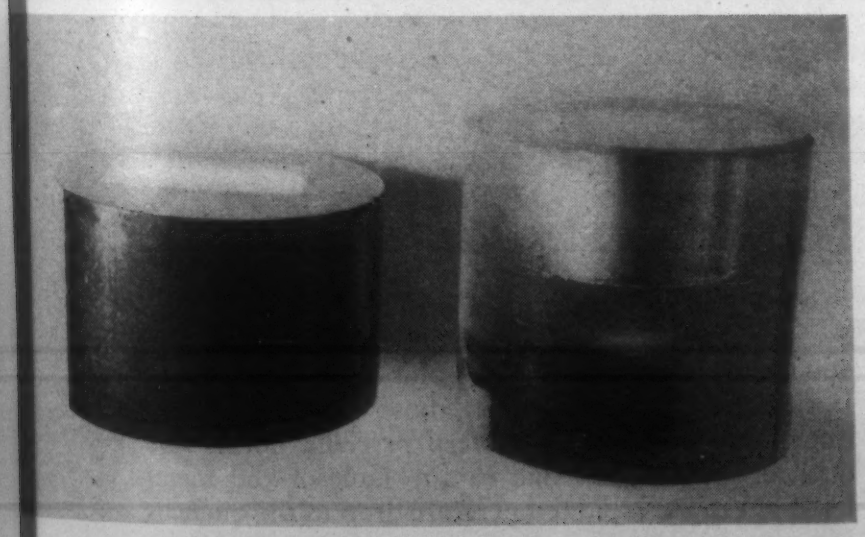


Fig. 1. Specimens embedded in both opaque and transparent plastic material. Note the magnifying effect of the transparent mount.

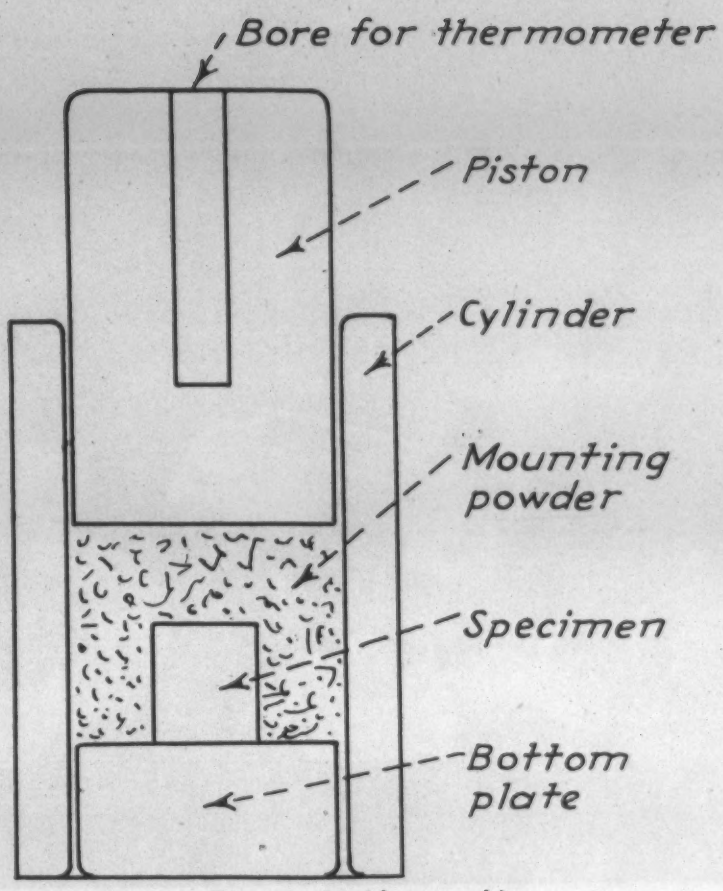


Fig. 2. Mold assembly.

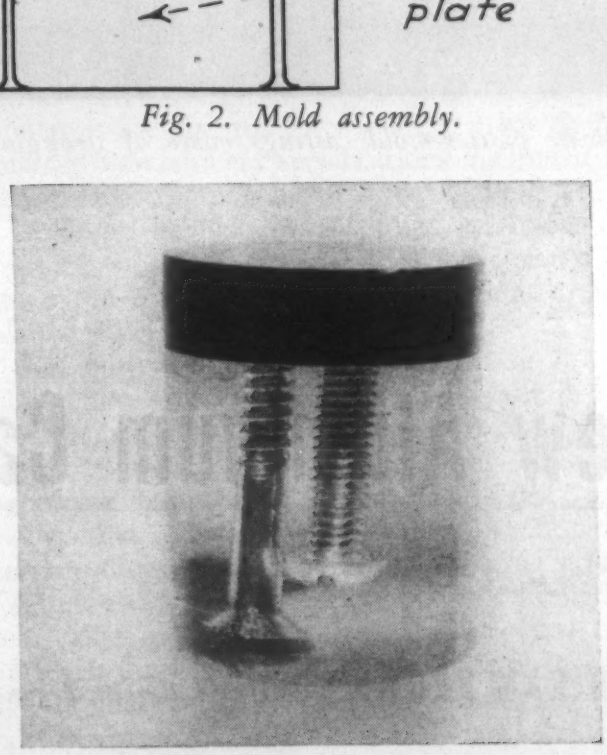


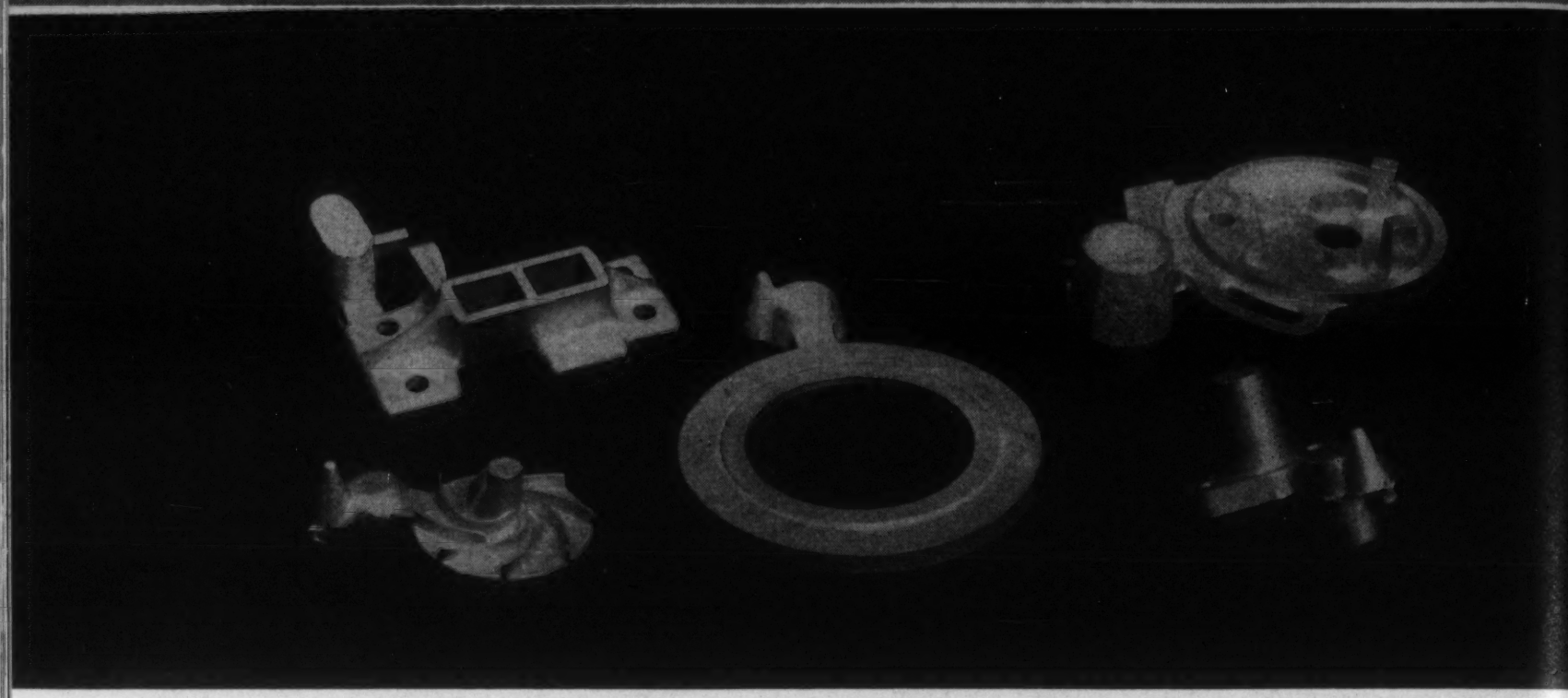
Fig. 3. The completed mount.

sembly, and is then treated in the same way as in making a simple mount. The specimens are sealed tightly into their respective holes by the melting and subsequently hardening mounting powder used in building up the completed mount, which is illustrated by Fig. 3.

In the illustrated case "Transoptic" mounting powder was used but thermosetting material may equally well be employed for the top part of the mount. This method is easily adapted to the mounting of any kind or shape of small specimens by cutting the holes into the holder disc in a suitable manner.

As will be described in a subsequent article on electropolishing, this method of mounting small specimens can also be adapted for use with the electrolytic polishing technique as a further improvement in that modern metallographic tool.

A Materials Article The interest shown by materials engineers in the relatively new group of aluminum casting alloys that require no high-temperature treatment continues to increase. Mr. Brown, who has been intimately associated with this whole development, describes herein the various types of strong-as-cast aluminum alloys in existence, presents their properties and indicates their present and potential fields of application.



Intricate plaster-mold castings made of strong-as-cast aluminum alloys.

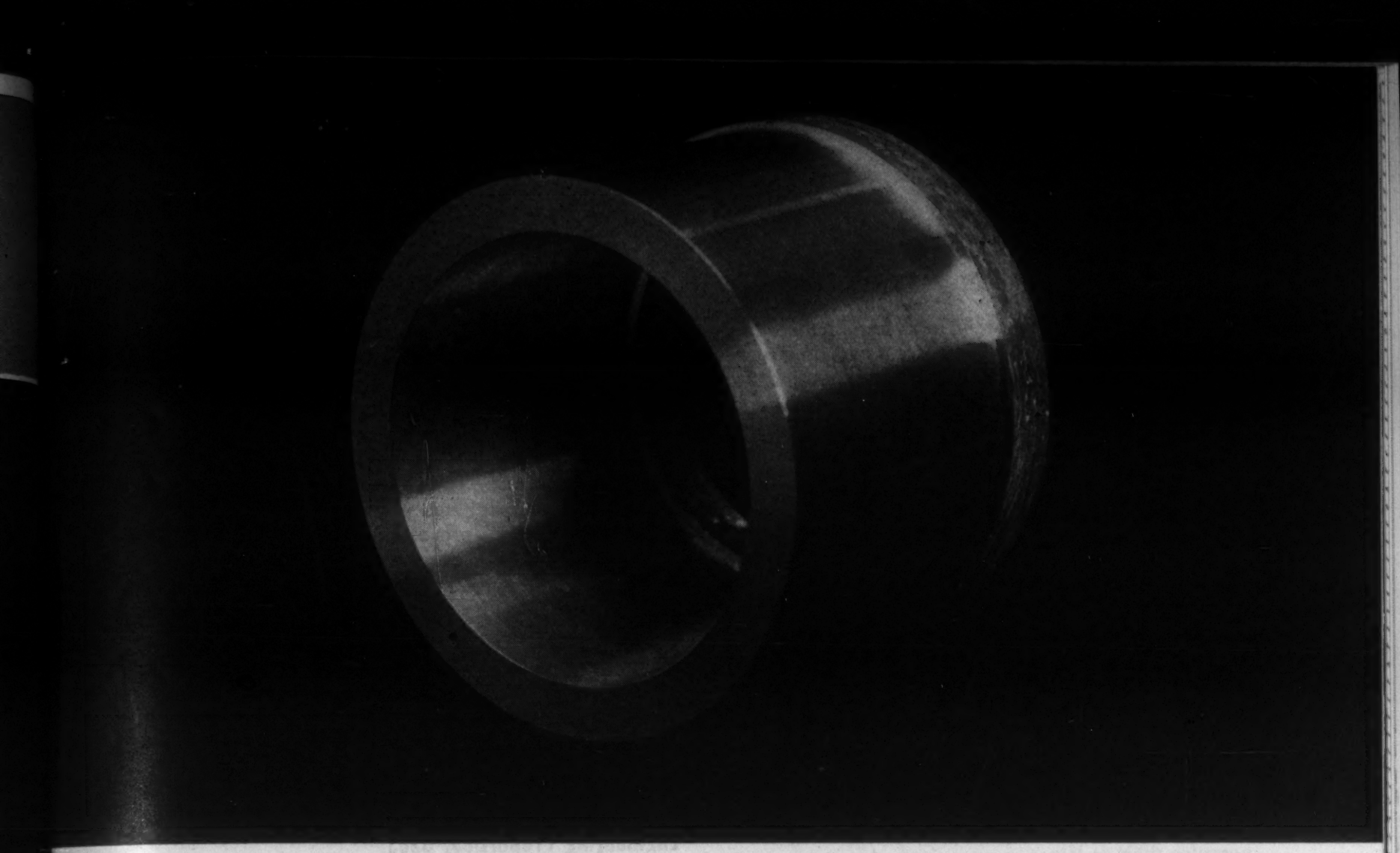
New Aluminum Casting Alloys —Strong As Cast

by **HIRAM BROWN** *Chief Metallurgist, Frontier Bronze Corp., Niagara Falls, N. Y.*

IN ORDER TO HAVE A BETTER UNDERSTANDING of the subject of this article it is probably necessary to begin by defining its title. The last three words "strong as cast" particularly require definition. By "as cast" we mean that the properties are obtained without the use of any high-temperature solution or quench heat-treatment, although low temperature aging may be used. By "strong" we mean that the physical properties are fully equivalent to those of the commonly used heat-treated aluminum alloys; that is to say, yield strength in excess of 18,000 p.s.i., tensile strength minimum of 30,000-32,000 p.s.i., and elongation of at least 3%.

Types of Strong-As-Cast Alloys

Alloys of this type were developed in order to overcome some of the difficulties resulting from the quenching which follows the solution heat-treatment. Intricate castings, particularly those of long thin sections, have a tendency to warp or crack during the quench. This is not due to any fault of the metal itself but to the rapid temperature drop in the quenching operations. The castings that warp must be straightened and this operation in addition to its time consumption often introduces stresses which are not relieved by the usual aging treatment. In



A centrifugal casting in 40E alloy.

addition to overcoming those difficulties, alloys that are strong as cast also eliminate the need for expensive heat-treating equipment. It is easy, then, to understand why a great deal of work was done to find strong-as-cast alloys.

One of the earliest of these alloys was the old 645 alloy which contained about 15% zinc, 2 to 3% copper, and 1% iron. It was also commonly called crank-case alloy years ago. At one time it was widely used both in Europe and the United States. It had probably the highest as-cast strength of any of the aluminum alloys. Unfortunately, however, it was found to embrittle, even if left at room temperature, to such an extent that after about a year the physical properties were only about half as high as in the original material. The corrosion resistance was found to be poor and the specific gravity was relatively high for an aluminum alloy. At the present time it is used very little in the United States.

A variation of 645 containing slightly higher copper with about 2% silicon has recently been marketed as the commercial alloy OH38 (see METALS AND ALLOYS, September 1944 issue, page 643). There has been no evidence to indicate that this alloy has overcome the undesirable features inherent in alloys of the 645 base. It is finding some commercial usage; however, although high physical properties are said to be obtained from the alloy it has so far failed to obtain Government specifications that would make it officially equivalent to the common heat-treated alloys.

Another as-cast alloy which has made its appearance contains about 5.5% copper with small amounts of magnesium, chromium, silicon and titanium and is known commercially as Barnite. Because of the copper content, corrosion resistance cannot be expected to be exceptional. Although high physical properties are claimed for the alloy it has so far not obtained Government specifications making it equivalent to the common heat-treated alloys.

Although they do have specific merit for certain types of work, in our opinion, the greatest disadvantage of both of the above alloys seems to be their low ductility.

The only aluminum alloys known to the writer which have successfully met the requirements are those containing zinc and magnesium, but free from copper as an alloying element. Europe, Germany in particular, has worked with alloys of this type for many years. It was found that aluminum-zinc-magnesium alloys responded readily to aging after heat-treatment to attain exceptionally high strength. The full value of alloys of this type was not realized, however, until it was found that some of them would age rapidly without any prior solution or quench heat-treatment. The one which has obtained the greatest commercial usage and which is best known in the aluminum alloy field is that which contains about 5% zinc and 0.5% magnesium with small amounts of titanium and chromium, and is designated as 40E.

General Behavior of 40E

That this alloy can attain properties equivalent to those of heat-treated alloys is demonstrated by Table I which shows the Air Corps specifications for alloys of the 40E type and for the common high strength heat-treated alloys.

The alloy ages naturally at room temperature. As soon as the metal solidifies it begins to increase in strength. Yield and tensile increase rapidly at first

and later on more slowly. Elongation decreases in the same manner. Within 21 days the metal reaches the required strength and thereafter changes only slightly. This is shown in the accompanying curves. Even after a year or a year and a half test bars are found to have elongation above the 3% minimum.

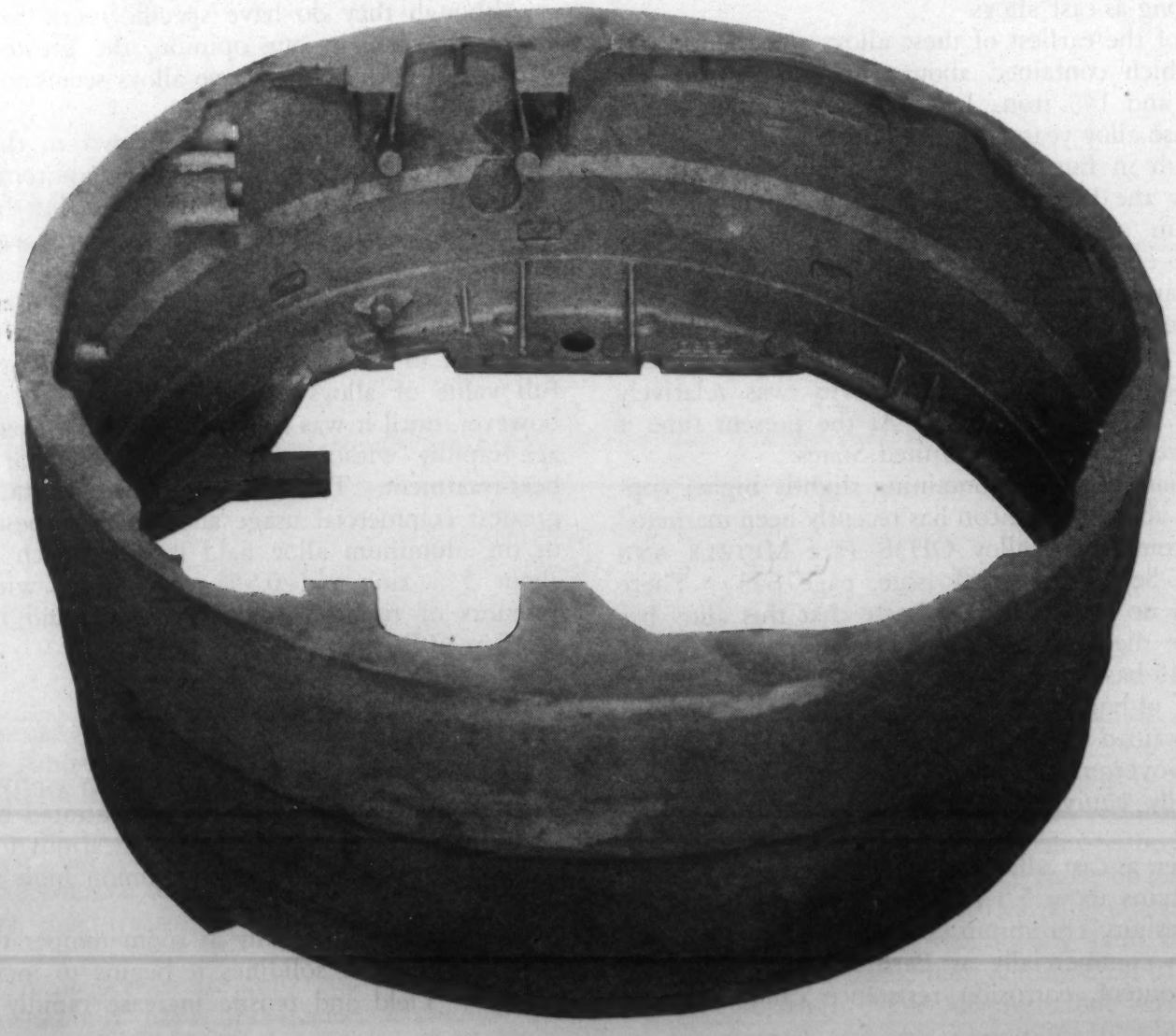
It is obviously undesirable to wait 21 days for castings to age naturally so an artificial aging of 10 hrs. at 356 F. was developed. This accomplishes in a matter of hours what would ordinarily require days. In addition to accelerating the aging it also raises the yield considerably and stabilizes the material so that close tolerance machining can be done without danger of distortion during machining. After the artificial aging treatment the tensile properties do not change even when the material is held for long periods of time following the aging treatment.

The aging tendency of the alloy is not great in the absence of either magnesium or zinc. This has led to the belief that the strength and aging tendency are due to the formation of a magnesium-zinc constituent represented by the formula $MgZn_2$. This constituent is more soluble in aluminum at high temperature than at lower temperature. As the temperature falls the solid solution becomes supersaturated and the excess $MgZn_2$ constituent precipitates just as rain falls when clouds become supersaturated by lowered temperature and are forced to precipitate some of the moisture in the form of rain. This precipitation continues until equilibrium is reached if cooling is sufficiently slow. However, even in sand molds the cooling is fast enough to retain in supersaturated solution some of the constituents which would otherwise precipitate. In order to obtain equilibrium the precipitate continues to be formed even in the solid metal.

Aging, or precipitation hardening, causes an increase in strength. This may be due to the keying action of the precipitated particles along certain crystallographic planes preventing slip, or to change in latticed conditions. This aging in the case of aluminum-zinc-magnesium alloys is more rapid than that of the usual cast aluminum alloys so strength is more rapidly and easily obtained. The particles are said to be submicroscopic in size because the microscope has so far been unable to detect them when maximum strength is obtained. Whenever the particles have become large enough to be seen under the microscope the maximum physical properties have not been obtained and over-aging is said to have taken place.

Engineering Properties, Uses

One of the outstanding characteristics of the 40E type of alloy is its high yield strength. With artificial aging yield strengths in excess of 25,000 p.s.i. are consistently obtained. The old 645 alloy had excellent machining properties and this has been re-



An interesting application of strong-as-cast aluminum alloys—the top turret of the Flying Fortress.

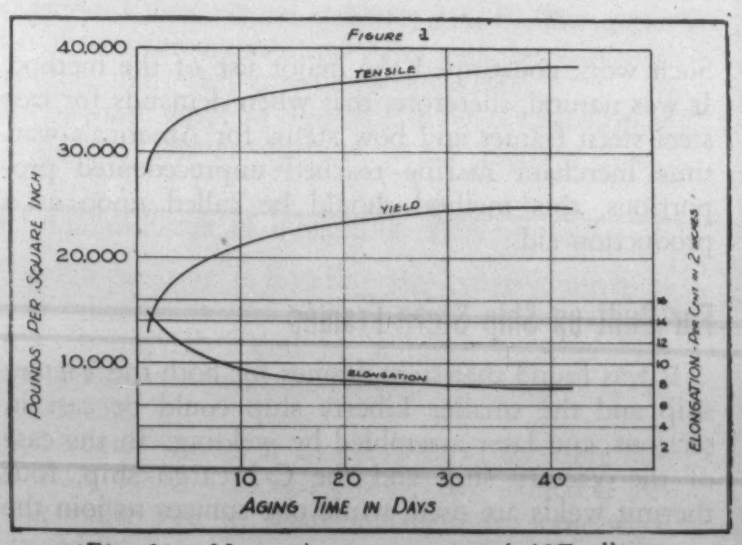
tained in 40E, without the relatively high specific gravity of the older alloy.

Corrosion resistance of the alloy has been tested in salt spray and by immersion in salt solution, and has been found equivalent to that of the aluminum-silicon base alloys. Stress corrosion resistance has also been tested under salt spray and in salt solution, and when stressed up to 75% of its yield strength the alloy was found to be satisfactory and to compare favorably with aluminum-silicon base alloys tested under similar conditions.

Actual shock tests using explosives have shown that 40E has greater resistance to this type of shock than any of the other alloys tested, including heat-treated and non-heat-treated alloys. This is believed to be a better test for shock than the Charpy or Izod tests.

An unusual property of the alloy is its ability to re-age to high strength after exposure to elevated temperature. Tests have shown that if held at 1050 F. for 2 hrs. and then allowed to air cool the metal will re-age to attain physical properties equivalent to those of the same metal not exposed to high temperature. This is shown in Table II. This behavior indicates that there may be important application of this alloy in welded or brazed assemblies. If assemblies containing heat-treated alloys are not re-heat-treated after welding or brazing the metal in many cases will be found to have lost about 20% of its tensile and 50% of its elongation. It may be difficult or even impossible to submit an entire welded or brazed assembly to re-heat-treatment. Alloys strong as-cast can be used to eliminate this difficulty. Alloy 40E has been successfully welded and brazed.

As would be expected, no alloy is perfect and 40E is certainly not a panacea for all the ills that beset the aluminum casting industry. The alloy is sluggish and difficult to handle. Shrinkage is higher than that of the aluminum-copper alloys and adequate gates and risers must be used to compensate for this. While somewhat "hot short" the alloy is about the same as 195 in this respect. It is also sensitive to impurities and to mold conditions. The casting difficulties can be partially overcome by higher pouring temperature. A pouring temperature of at least 30 F. higher than that of corresponding aluminum-copper castings should be used. Fortunately the alloy is not so susceptible to pinhole porosity or gas pick-up as are the aluminum-copper alloys so the increased pouring temperature does little harm.



(Fig. 1) Natural aging curve of 40E alloy.

Alloys of this type have been successfully used in Germany for bearings. They can also be centrifugally cast, and plaster cast to attain sand cast specifications.

Because of the properties of the alloy and its method of obtaining those properties it should have even greater possibilities after the war, particularly in small foundries that would like to enter the high strength aluminum alloy field, but do not have or want heat-treating equipment.

Alloy 40E has found extensive use where shock and pressure tightness are important factors. The top turret of the Flying Fortress has been made exclusively of this alloy. Among other aircraft uses are gun mounts, nipples for self-sealing gas tanks, carburetor and oil feed lines, high altitude oxygen equipment, heat exchanger oil coolers, etc.

The Navy Bureau of Ships has found the alloy to be satisfactory where corrosion resistance was necessary. Among their uses are thousands of axial flow wheels, large quantities of radar equipment, structural parts for Navy aircraft, Naval ordnance mines, and antenna equipment for PT boats.

The parts listed above are manufactured by Frontier Bronze Corp., but there are 47 other foundries also working with the alloy for the same or their own uses. More than 3,000,000 lbs. of the alloy was used in 1944 with many sub-licensees still not at the height of production.

Table I. Government Specifications Covering High-Strength Cast Aluminum Alloys.

Spec.	*General Type of Alloy*	*Yield (min.) p.s.i.*	*Tensile (min.) p.s.i.*	*Elong. (min.) % in 2 in.*
AN-A-17	5.25 Zn	20,000	32,000	3.0
AN-QQ-A376	5% Si, 0.5% Mg	20,000	32,000	2.0
AN-QQ-A364	7% Si, 0.3% Mg	20,000	30,000	3.0
AN-QQ-A390	4% Cu	18,000	32,000	3.0

Table II. Re-aging of Alloy 40E After Exposure to High Temperatures.

Treatment	*Yield-Strength, p.s.i.*	*Tensile-Strength, p.s.i.*	*Elongation, % in 2 in.*
21 days, room temp., no exposure to high temp.	25,000	36,700	6.5
2 hrs. 900 F., air cool, aged 21 days room temp.	25,100	35,600	5.5
2 hrs., 1000 F., air cool, aged 21 days room temp.	25,400	36,800	6.0
2 hrs., 1050 F., air cool, aged 21 days room temp.	24,800	38,300	6.0
2 hrs., 1000 F., air cool, reheat 2 hrs., 1000 F., air cool, aged 21 days room temp.	25,550	36,000	5.25

A Methods Article Once regarded as an exclusively repair tool, thermit welding has blossomed forth in recent years as an important production method for original construction. This new trend has been especially noticeable in the fabrication of heavy equipment like ship stern frames, railway rails, etc. Mr. Rose discusses the nature and utility of thermit welding and describes its engineering applications in the heavy-fabrication field.

Railroad rail for the Moffat Tunnel, on the Denver and Salt Lake Railroad, being welded into continuous lengths.

Thermit Welding in Heavy Fabrication

by **KENNETH ROSE** *Engineering Editor,* METALS AND ALLOYS

PRODUCTION PROBLEMS associated with the war have given a tremendous impetus to all types of welding processes. Arc welding, gas welding and resistance welding have been applied to industries in which they were formerly little used, and with a success which will assure their permanent installation as production methods in those industries. Another welding process, one of the oldest, has also been adopted for new techniques in production. Applications of this, the thermit process, while not as widely publicized as the others, are of great importance, particularly in heavy construction.

Thermit welding has been utilized for emergency repairs to heavy cast and forged steel parts for years. Such work constituted the major use of the method. It was natural, therefore, that when demands for cast steel stern frames and bow stems for America's wartime merchant marine reached unprecedented proportions, this method should be called upon as a production aid.

For Built-up Ship Stern Frames

It was found that stern frames for both the Victory ship and the smaller Liberty ship could be cast in sections, and later assembled by welding. In the case of the Victory ship and the C-2 cargo ship, four thermit welds are used, while one suffices to join the

two sections of the Liberty ship stern frame. Bow stems are assembled by two welds.

Casting of these frames in one piece, roughly 20 by 26 ft., and weighing as much as 37 tons, was a somewhat difficult and unwieldy task. Furthermore, the making of these large, heavy castings was limited to only two or three foundries on each coast and the transportation of these large pieces presented a considerable problem. The smaller parts can be made in almost any foundry, their transportation is simple and the pieces can be assembled by the shipyard forces by thermit welding. These smaller castings are assembled without the need for subsequent machining of welded areas or of stress-relieving the assembly.

The welds are not difficult to make, and require no specially skilled labor. Parts to be joined are aligned on a bed plate or cradle, the ends cut with a torch to provide the proper gap, usually 1¼ to 1½ in., the weld gap is filled with wax, and a wax collar is modeled around the weld site. Vent holes, made by embedding ropes or rods in the wax and later withdrawing them, will speed its melting during the preheating stage. Five pounds of thermit mixture are required for each pound of wax in the mold.

A specially designed mold box, of steel plate, is placed around the weld area, and thermit molding material is rammed up. Gate and riser patterns are placed as the mold is rammed, and a slag basin is formed at the top. The wooden patterns are then removed, and the mold is preheated with a kerosene preheater, burning out the wax and finally bringing the ends of the sections to a red heat. From 3 to 10 hr. may be required. The cavity is then flushed out with a blast of compressed air to remove any loose sand, and heating gates are plugged with prepared cores.

During preheating the thermit crucible is put into position above the mold box, filled with the required amount of thermit powder and, as preheating is being completed, the ignition powder is placed on top of the thermit. Several match heads embedded in the powder will assist in quick firing. The heated end of a long rod, touched to the match heads, fires the mixture, and after about 30 sec., when boiling has ceased, the molten metal is tapped into the mold.

As soon as the slag in the slag basin has solidified the steel mold box may be removed, but the baked molding composition must remain in place until the steel sections have cooled to about 300 F. The material is then cleared away and gates and risers burned or chipped off. This completes the weld.

For certain types of production work permanent patterns may replace the wax in the method given.

Other Construction or Demolition Uses

Thermit welding is entering the construction picture in other fields also. A large single-throw crankshaft is being fabricated by welding together two forged shafts, two webs, and a pin. Four welds make the assembly.

In the construction of an ore dock at the Republic Steel Co.'s South Chicago works, two concrete retaining walls 300 ft. apart and 830 ft. long were connected by tie rods to prevent spreading when the bin was filled with ore. The tie rods, 7 in. sq., were made by welding together seven 46-ft. lengths of steel bar.

Another recent application of the thermit process is as a cutting method in demolition work. A traveling ore bridge at the South Chicago plant of Interlaken Iron Corp. was scrapped last spring. The structure was 300 ft. long, 80 ft. high, and 30 ft. wide—a sizable item to be handled. By placing thermit retorts around four of the eight steel columns supporting the bridge, the entire mass was razed in 51 sec. Electrical ignition of the thermit permitted the firing to be done from a distance, without danger to the workmen. The skyride tower at the Century of Progress was similarly demolished by thermit cutting.

The Nature of the Process

The reaction which forms the basis for thermit welding was discovered by Dr. Hans Goldschmidt, of Essen, Germany, more than 40 yr. ago. It is quite simple—aluminum and a metallic oxide react to give

The welds are made in groups of fours.

aluminum oxide and the formerly combined metal. While the reaction is most widely used with iron oxide, it was first patented in 1897, in connection with the reduction of chromium and manganese. A few years later the process was applied to welding by the Goldschmidt Thermit Co. This company eventually was acquired by Metal and Thermit Corp.

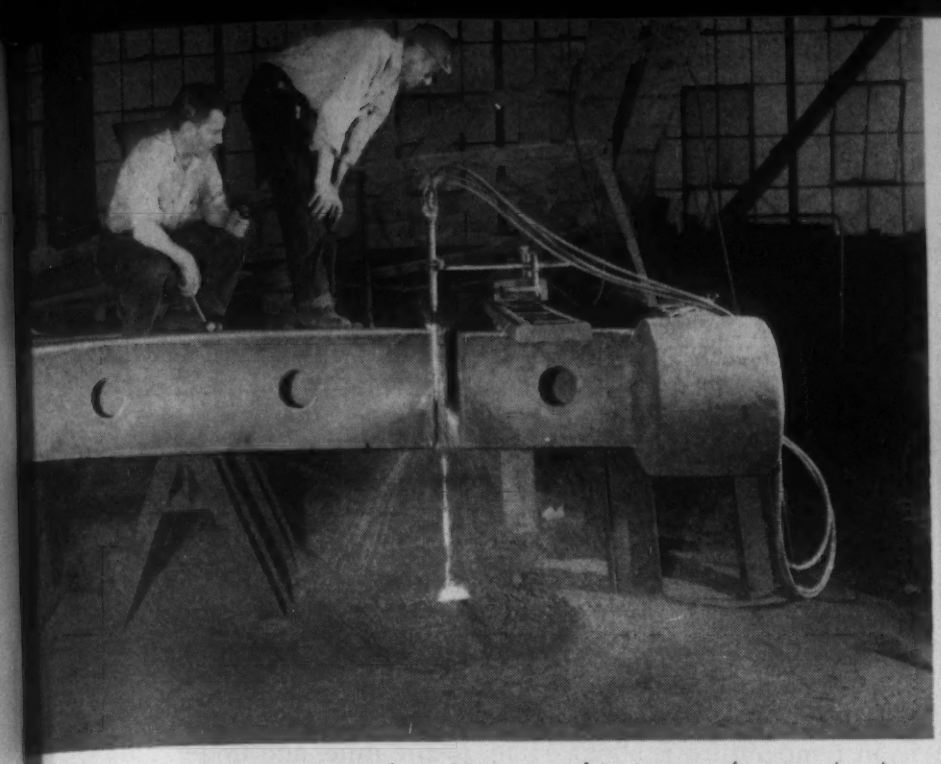
Thermit powder, as ordinarily employed, is a mixture of about 23.25% fine granular aluminum and about 76.75% processed mill scale. Since high heat is the end result of the reaction, the mill scale is roasted to increase the percentage of oxygen in the material. The equivalent FeO of the mill scale decreases from 56%, through 29%, corresponding to Fe_3O_4, or magnetite, to a final 18% FeO equivalent. When reacted, steel to the extent of about one-half the original weight of thermit powder is produced.

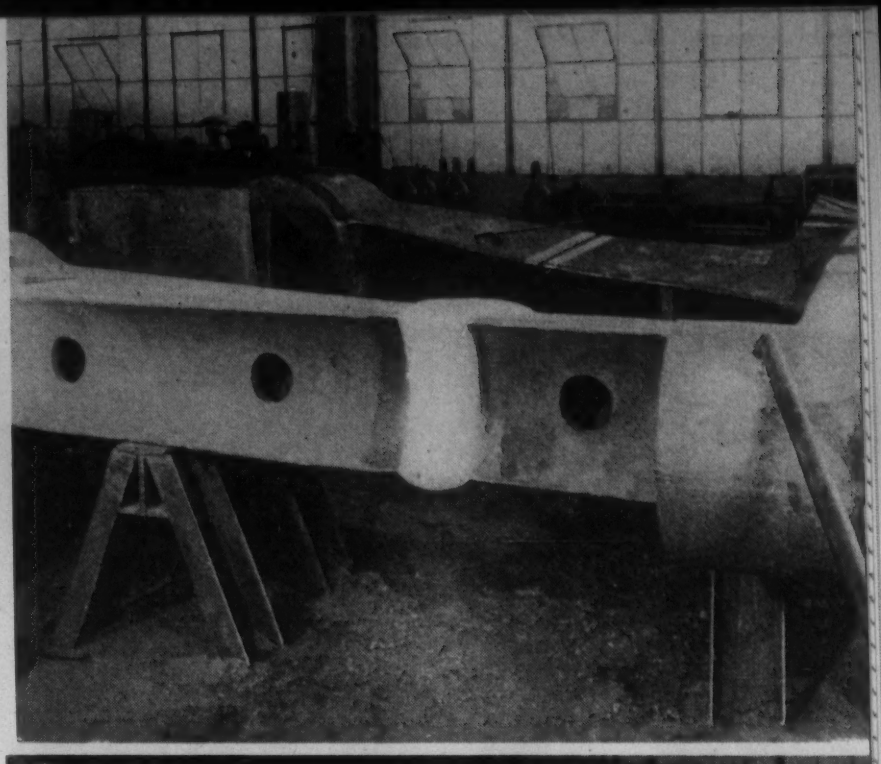
The temperature of the reaction is about 5000 F., but the metal as poured from the crucible is somewhat cooler because of the heat taken up by the crucible itself. Advantage is taken of this high temperature to obtain a greater yield of steel by adding about 15% of steel punchings to the thermit mixture on most jobs. The temperature of the poured metal is in this way reduced to about 4000 F. For most welding applications it is desirable to have the poured metal at about this temperature to assure complete fusion with the work, so that the quantity of punchings added for these applications is generally restricted to 15%. However, if desirable for some special purpose, the quantity of steel may be further increased by adding more punchings. Even with 50% punchings, the poured metal will have a temperature of 3300 to 3400 F. The punchings used have about 0.20% carbon and 0.60 to 0.70% manganese.

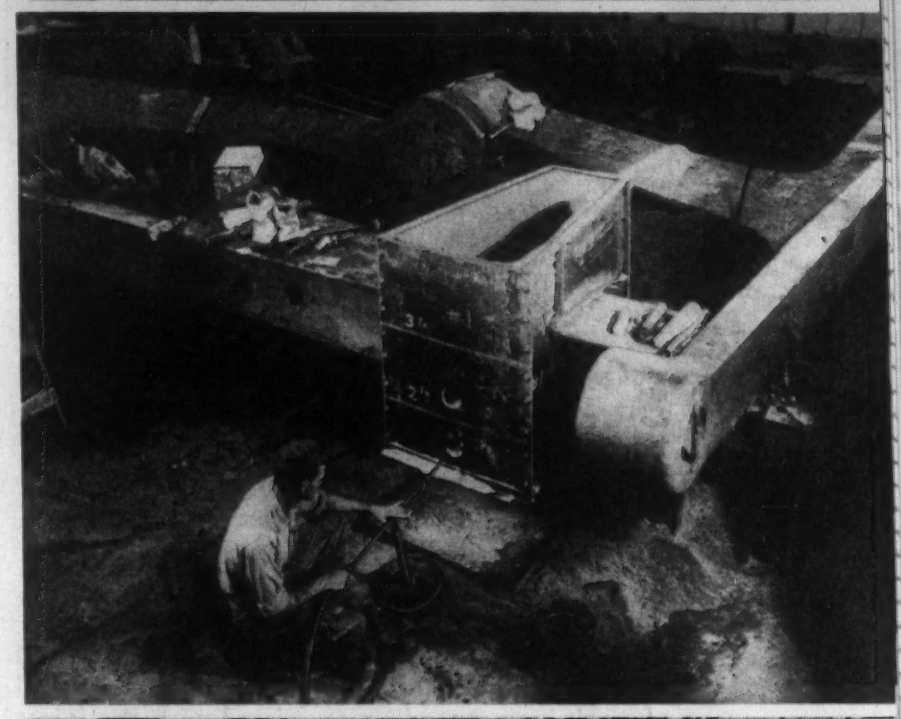
The reaction itself is quite vigorous, and high temperatures are produced, but the thermit powder is not dangerous to handle. Even an ordinary flame will not start the reaction. A special ignition powder developing a temperature of 2800 F. is used as the initiator.

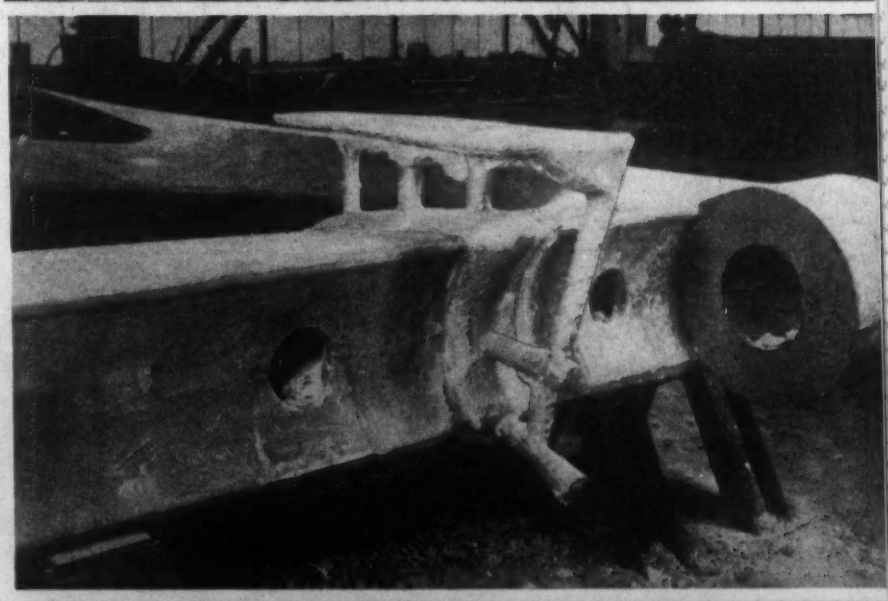
In addition to its use for welding steel, the thermit reaction is sometimes used for the preparation of other metallic elements or mixtures. Manganese and chromium may so be prepared, and ferrotitanium is another commercial product available by this method. In welding alloy steels, weld metal of almost any analysis can be obtained by using various mixtures of metallic oxides as reagents, or by adding pieces of the desired metals or alloys to the thermit mixture, to be fused by the reaction. Among the elements whose

Joined into 1000-ft. lengths, the rail is skidded into place in the tunnel, and there joined by closure welds.









Fabrication of a Victory ship stern frame, in its various steps. (a) Ends are cut with the oxyacetylene torch. (b) A wax pattern is made at the weld site. (c) Mold box in place, the work is preheated. (d) The thermit is poured, and, after cooling, mold material is removed. (e) The finished weld—gates and risers have been burned off.

oxides may be used as reagents are tungsten, vanadium, titanium, nickel, molybdenum, silicon, columbium, and boron.

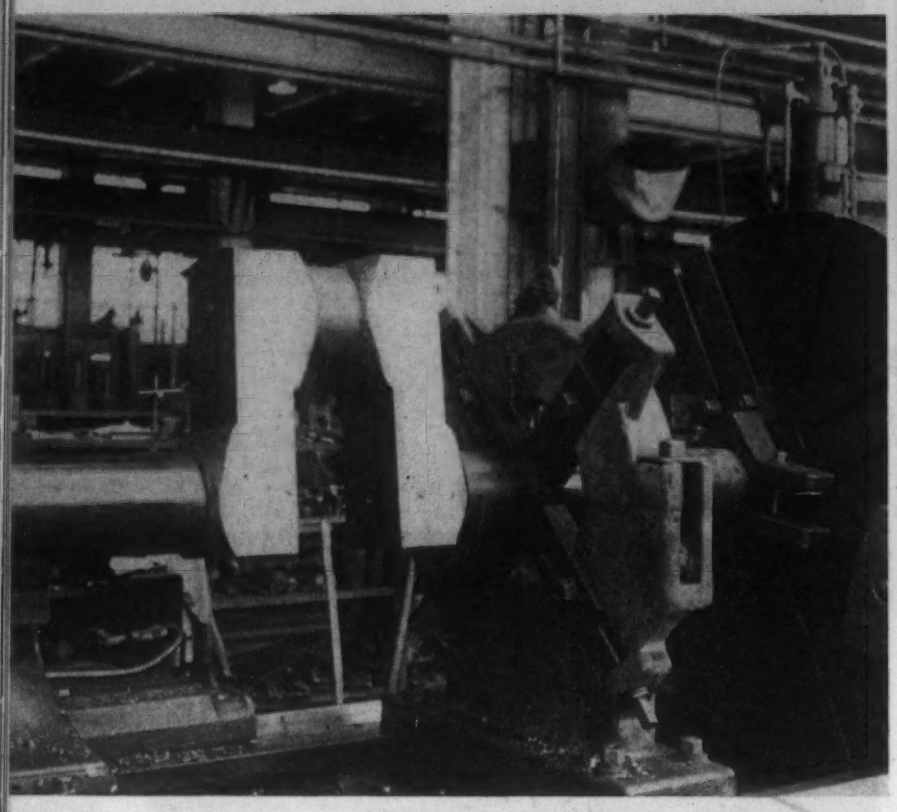
By reacting oxides of nickel and chromium simultaneously with the iron oxide, it is possible to obtain an 18-8 stainless steel as the weld metal. Nickel steels, chromium steels, manganese steels, molybdenum steels, and others can be prepared by additions to the standard thermit mixture.

Thermit steel as ordinarily used for welding contains about 0.20 to 0.30% carbon, 0.50 to 0.60% manganese, 0.25 to 0.50% silicon, and about 0.07 to 0.18% aluminum. The presence of aluminum during the reaction, and as a residual, results in a completely deoxidized steel even at the high pouring temperatures. A forging thermit, containing additions of manganese and mild steel punchings, is used for welding steel; a cast-iron thermit, with ferrosilicon and steel punchings as additions, for welding cast iron.

Thermit welding has been a standard procedure for many years for heavy repair work, and this was its major use. A special mixture termed wabbler thermit was developed for building up worn wabbler ends of rolls and pinions for steel mills. Machine frames, in steel or cast iron, have been successfully welded. Large crankshafts have been welded and have given years of service. While cast iron parts can be welded, the particular application sometimes causes difficulty because of the shrinkage of the weld metal, ordinarily twice that of cast iron. Thickness of section in cast iron should be about eight times the length of the crack if a successful repair is to result.

Welding Railway Rails in Tracks

Another field in which the process has been long established is the welding of railway rails. While several other processes can be used, the thermit process is the only one that is suitable for welding rails "in track." This gives it a considerable advantage for repair work.



A heavy crankshaft, fabricated by thermit welding.

A widely-publicized example of the use of welded rail is that of the Moffat tunnel, located about 50 miles northwest of Denver, Colo. It is 6.21 miles long, and passes under the Continental Divide at a maximum depth of 2,600 ft. Single-tracked, it contains about 66,000 ft. of continuous-welded rail.

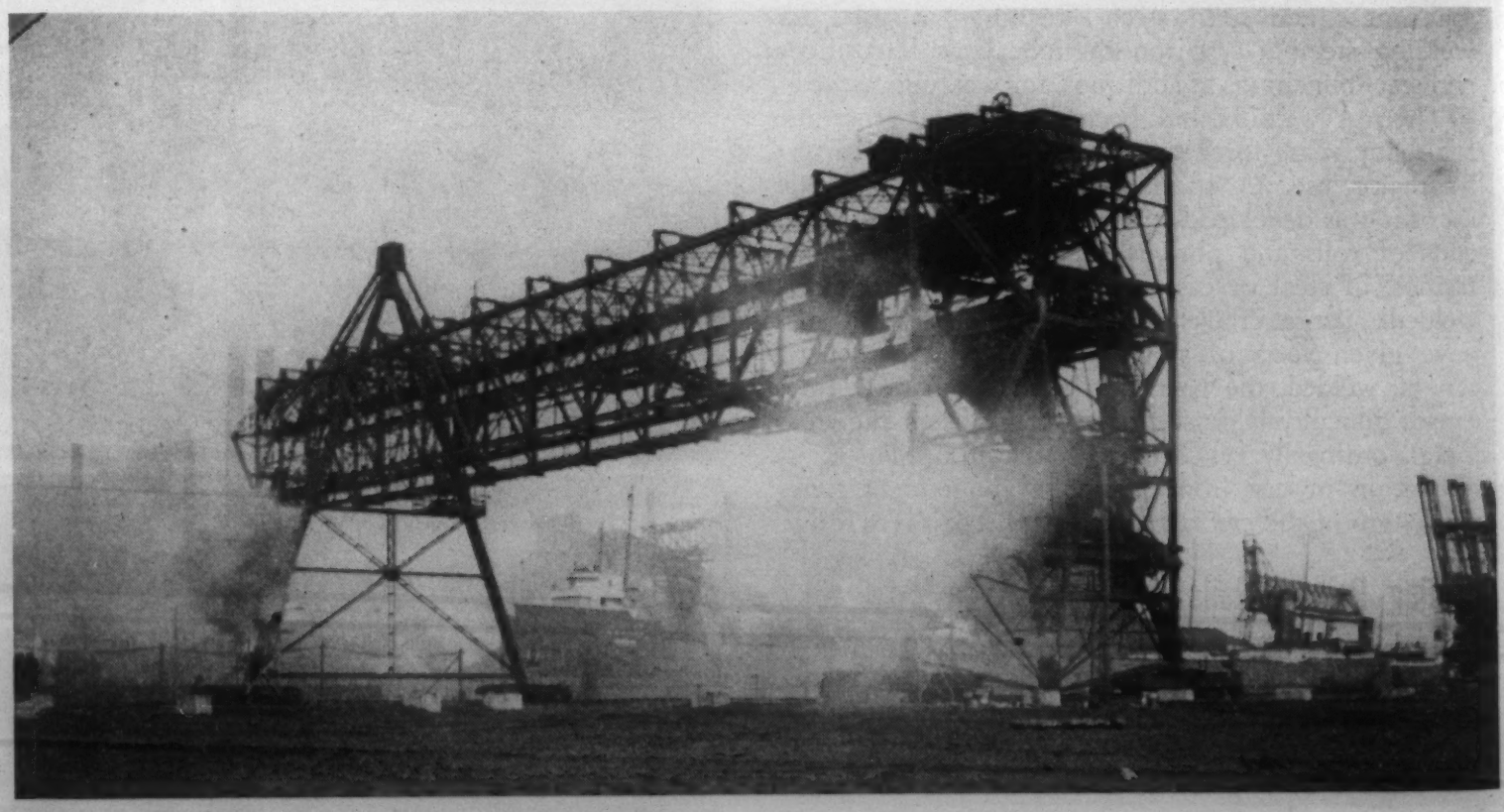
The use of continuous lengths of rail inside a tunnel has obvious advantages. Maintenance work in such location is difficult at best, and a large percentage of track maintenance is associated with the joints between rails. Water always drips down from the roof of the tunnel and the sulphurous fumes convert this into sulphuric acid, which will attack the rail especially around any bolts or holes in the rail-ends. The placing of continuous rail in the tunnel was begun in the fall of 1942, discontinued the following January because of the weather, resumed that spring, and completed in August, 1943.

The rails were placed on a welding bed outside the tunnel, welded into 1000-ft. lengths, skidded into place in the tunnel, and there made into 33,800-ft. sections with closure welds. Full-fusion thermit welds were used throughout.

A question that immediately arises in connection with welded rail is—what of thermal expansion? The normal expansion of rail under a 100-deg. rise in temperature is about 41 in. to the mile, and under some reported extremes of temperature might exceed 60 in. This is met in two ways—(1) by placing the rail while temperature is at a median value, so that the stress producible by the maximum change is never reached, and (2) by restraining the motion of the rail with spring clip fastenings, with anti-creepers, and with the rail ends themselves.

Welded railroad rail in long lengths has been used in this country in tunnels since 1930, and in the open since 1932. Its use by street railways dates back much farther. Temperature conditions are not so extreme in tunnels, but corrosion and abrasion are frequently serious problems.

The thermit reaction is used in the foundry for increasing ladle temperatures, or for keeping metal in the risers of large steel castings in a fluid state for a length of time greater than usual. Metal for small castings can be prepared by this process, and this has been done in isolated places without melting equipment, particularly in the mining districts of Australia and South Africa. The procedure would be uneconomical under ordinary circumstances.



Thermit demolition of a Republic Steel Corp. travelling ore bridge at So. Chicago.

A Materials-and-Methods Article One practice that the war has promoted to a major engineering activity of interest to both materials and process engineers is the treatment of magnesium alloy castings to plug up their pores and make them pressure-tight. A number of impregnating agents and treatments is now available, and in this article Mr. Knight compares them generally and describes more specifically the applications and service performance of one very recently developed synthetic product.

Fig. 1. Correction of porosity in magnesium castings implies no lack of "soundness," the latter being assured by careful fluxing of the metal during pouring, shown here. Courtesy: Hills-McCanna Co.

Modern Impregnating of Magnesium Castings

by **HAROLD A. KNIGHT** *News Editor,* METALS AND ALLOYS

FROM TIME IMMEMORIAL metals have been porous in greater or lesser degree, a failing the more marked where internal pressures from liquid or gas had to be endured. Thus gray cast iron was often found embarrassingly porous, with many crude devices for sealing the pores, a common practice being the use of some chemical that would quickly oxidize or rust the iron, creating a "self seal." "Pin holes" in lead coatings are automatically filled by corrosive or chemical action involving the interplay of lead and iron atoms upon each other. In the case of cast iron ever better metallurgical and foundry practice now tend to minimize or eliminate the porosity.

Some of the materials now receiving increased prominence, like magnesium and aluminum, inherited some of the old porosity problems. A. T. Peters, research department, Dow Chemical Co., Midland, Mich. describes porosity for us as follows: "Porosity

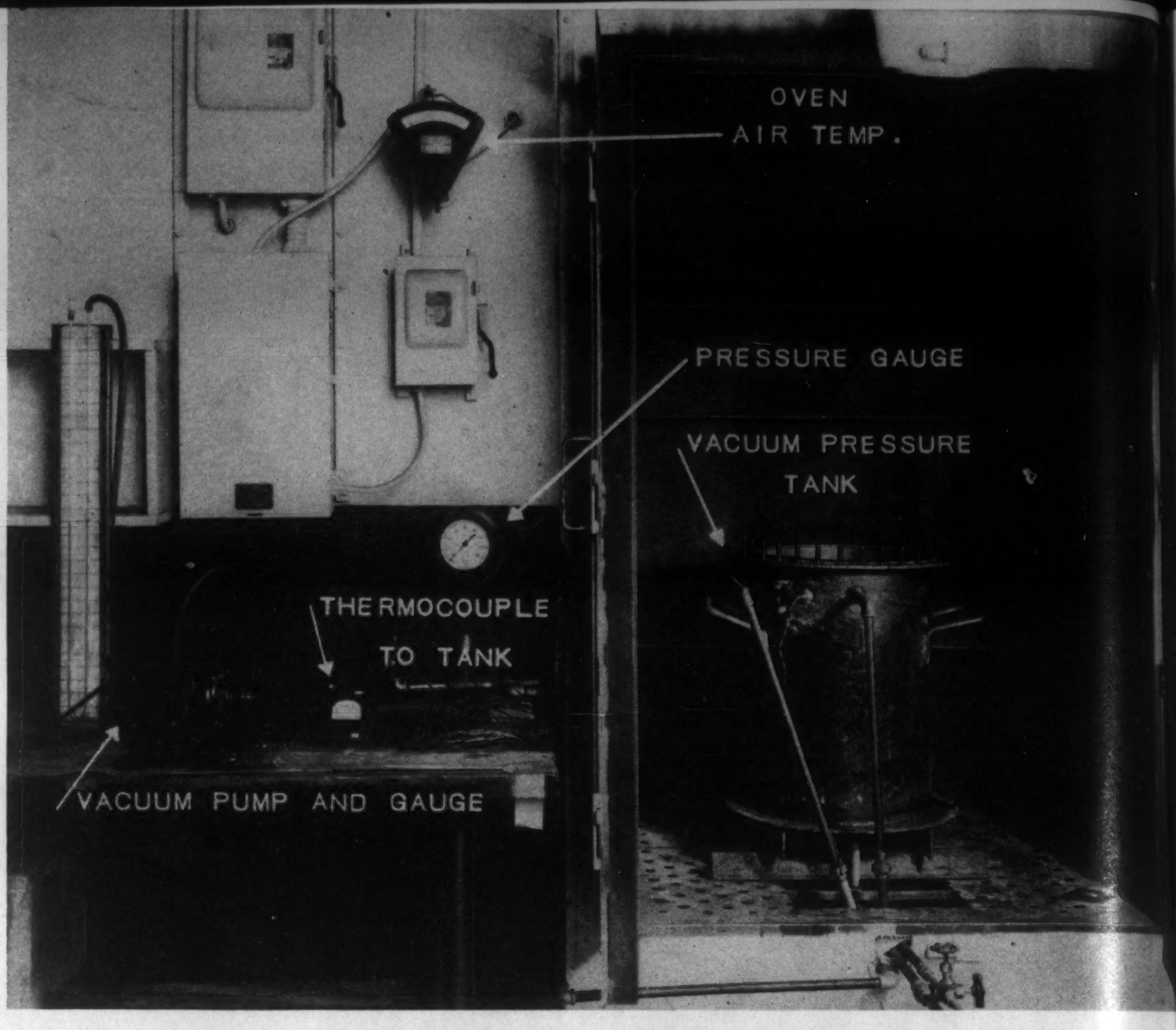


Fig. 2. This laboratory equipment for impregnating castings, designed to approximate production conditions. The procedure involved in its use is described in the text under "Tests."

in metals is the result of either the contraction in volume of the metal, or the precipitation of dissolved gas, during solidification or both. It may exist in several different forms, such as interdendritic shrinkage, pin holes, or primary shrinkage holes.

"Porosity exists in magnesium alloys in varying degrees, depending on the alloy composition, casting conditions and gas content. It has received more attention in magnesium than in other metals for a number of reasons. Magnesium alloys are used at the present time for aircraft parts demanding the highest possible quality. Porosity can be more readily detected by radiographic methods in magnesium alloys than in any other metal.

"The magnesium alloys used for the manufacture of castings have a broad temperature range of solidification during which time the metal exists as a partially frozen mixture of liquid and dendritic crystals. Pockets of the liquid phase frequently become trapped in a network of frozen metal to such an extent that there is no way to feed them when they freeze and microshrinkage results. Feeding is made more difficult because the extremely low density of the metal provides only a small hydrostatic pressure.

"The difference in the occurrence of porosity in magnesium alloys and in other metals, is one of degree. The same principles used for producing high quality castings in other metals can be applied effectively to produce high quality magnesium alloy castings, when due consideration is given the specific characteristics of the alloy."

Pores may vary in diameter from capillary dimensions to ten thousandths of an inch.

Development of Compounds for Magnesium

Where use in aircraft is concerned the industry had to "take it and like it" for lightness is the chief physical needed. Doctor it up, if necessary, but use it! So they first doctored with sodium silicate, filling the pores of the metal with it, but that is a highly abrasive compound and where not properly cleaned off rapidly dulls machine tools and chips were coming off to clog oil lines, etc. Moreover this "water glass" is over 50% water which has no sealing efficiency.

In more recent years organic compounds based on vegetable oils became popular, having been found superior to the silicate. Tung (or China wood) oil proved quite a happy solution at the time. It has fast drying properties and comparatively low viscosity. Yet, in terms of efficiency and/or complete impregnation, its viscosity was very high. In heating it certain complications set in. Just then the WPB commandeered available tung oil for other purposes.

It was now logical to try to develop other vegetable oils that had previously been found unsuitable. The Dow Chemical Co. recommended the use of monomeric styrene (used in artificial rubber) in connection with dehydrated castor oil and later linseed oil. Monomeric styrene is a solvent and is also resin-forming, converting to polystyrene when catalyzed with benzoyl peroxide ("Lucidol") and heat. Such mixtures were an improvement over the original tung oil method. Yet the catalyst is expensive and dangerous, being inflammable and highly explosive and an added hazard to an already hazardous magnesium plant.

At length Ault & Wiborg Corp., Cincinnati, developed its No. 988 Metal Impregnating Compound, which is an alkyd resin fatty acid, modified and reactive with monomeric styrene. It is usually mixed 40 parts of No. 988 to 60 parts of monostyrene (by weight), though conditions often call for variations. Its sponsors claim that it is superior to the tung oil method and that when tung oil is plentiful, No. 988 will maintain a lead. In fact where large quantities of tung oil were suddenly made available manufacturers have not returned to its use. From a cost standpoint the two are now on an economic level. (As this is written, the current market on raw tung oil is 39c per lb. against 23c for No. 988 compound.)

Principal Applications

The compound and process is so new that no thorough and exhaustive tests have yet been published. However, we have seen enough confidential reports of tests made as to be highly impressed with it. Castings have been impregnated with it that had to meet a test of 1000 p.s.i. though usually requirements are far less rigid. Cylinder heads, so treated, have stood the test in service for at least six months, according to the records.

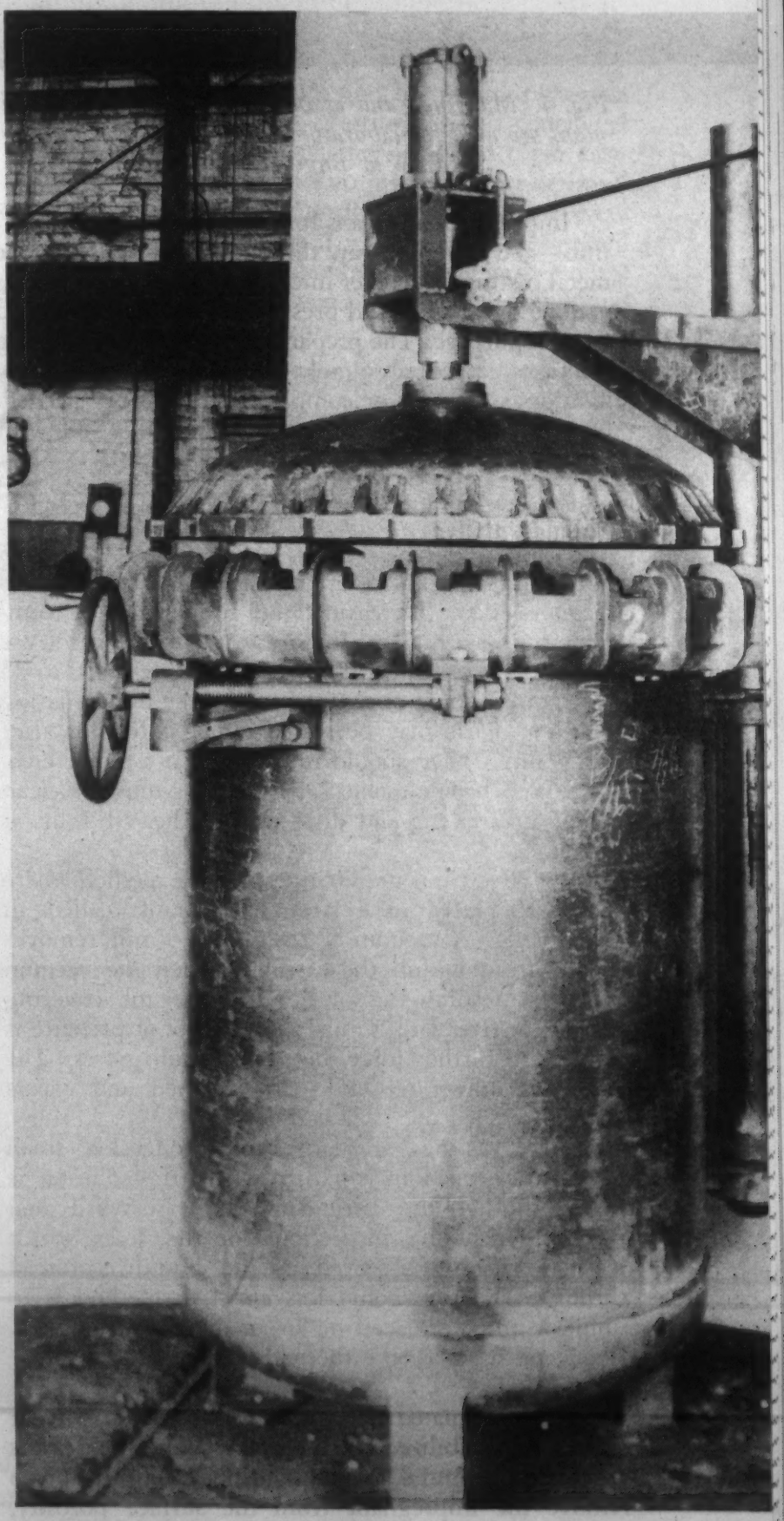
Monsanto Chemical Co. has brought out an impregnating compound, reported by those who have used it alongside the A & W compound, to be very similar to the latter. Both seem to work on the same principle and result in the same type of reaction with monomeric styrene.

The Ault & Wiborg No. 988 compound naturally finds its greatest use in the aircraft industry and in castings used as parts of pressurized equipment, such as hydraulic equipment, pumps, aircraft superchargers, air pressure equipment, etc. It is used outside of aircraft, as in army binoculars where the die cast tubes must be kept air and moisture tight to protect the efficiency of the prism.

A typical instance is where leakage of magnesium castings was encountered in 30 to 40% of the units. One impregnation with No. 988 brought leakage down to 5%. In several cases a re-impregnation has accomplished a perfect job. No. 988 is not advised for treating castings where copper is an ingredient because of unfavorable reaction between the copper and the styrene. Greatest war and post-war users will be processors of magnesium and aluminum. There seems a good future for die castings, gray iron castings and in iron powder metallurgy.

Probably the compound, generally speaking, will be used mostly for salvage—but in the case of aircraft engines the salvaging is a permanent production operation. Thus the engine magnesium castings are considerably porous, which condition requirements will not tolerate.

Fig. 3. A popular model of autoclave for impregnating in the production line is that manufactured by Jackson & Church Co., Saginaw, Mich. Here pressure or vacuum may be applied and electrical heat provides baking or curing.



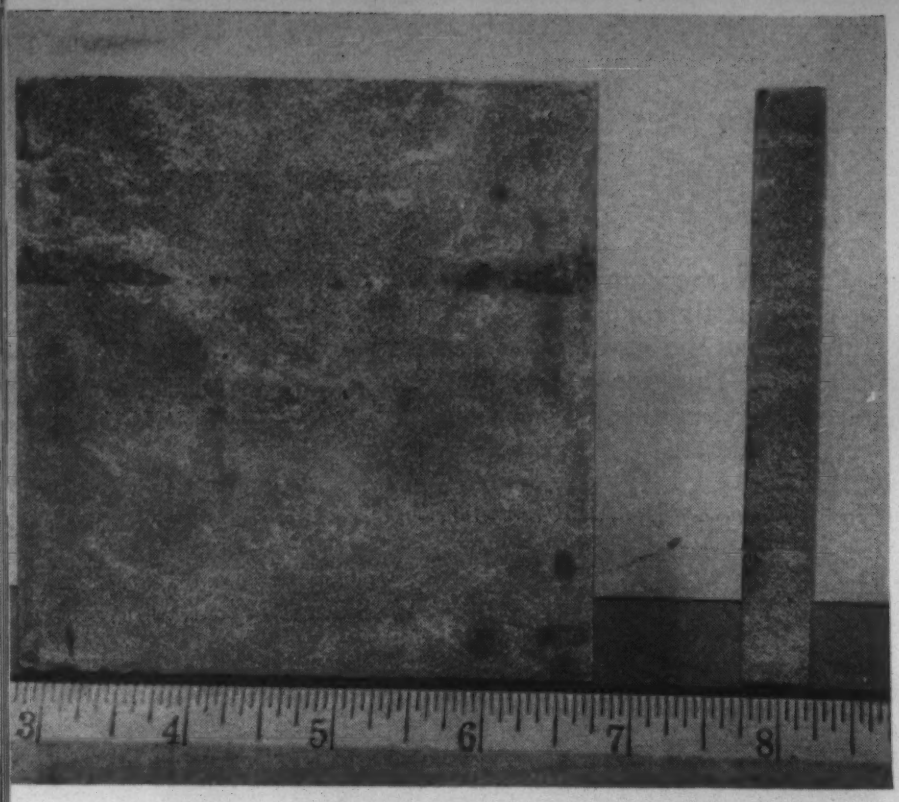


Fig. 4. Machined and etched magnesium alloy specimens are used for laboratory impregnation. (Courtesy: S.A.E. War Engineering Board.)

"Impregnation" means forcing the agent, or "sealer" into—and all the way through—the walls of the metal castings wherever microporosity is present. This is done by vacuum and pressure, or a fixture designed for this purpose. The preparation of the impregnating solution requires absolutely no technical control. No hazardous catalysts or complex chemicals are needed. One mixes the desired proportion of No. 988 with monomeric styrene.

Methods of Use

Usually 40 parts compound to 60 parts styrene is recommended. Increasing the proportion of compound gives a higher viscosity to the solution for use where pores are large. Usually a viscosity of 10 to 25 centipoises should be maintained for the impregnating solution. Parts may be sealed either before or after machining. They should first be given a slight etch, say with "chrome-pickle." All surfaces must be clean of oil, grease, etc. and dry—perhaps heated 1 hr. at 250 F.

Most effective is the vacuum-pressure method where parts are placed in a large sealed tank, called an "autoclave." A vacuum of 28 in. for 15 min. removes all air from within the castings. Then the vacuum is allowed to draw the solution into the tank, covering all parts. After 3 to 5 min. about 90 lb. of pressure is applied to further force the solution into pores. The liquid is drawn off and parts drained and excess coating washed off.

Where castings are large and production small each part is held in a fixture where the solution is forced through the castings walls. It serves a dual purpose, including inspection, for the areas which leak are readily observed as the liquid is forced through. A simpler and less effective method is to immerse the warm casting in an open tank of solution kept at 65 F., the thermal change causing some penetration.

The impregnated casting is washed by a solvent cleaner or a stabilized alkali cleaner. Vapor degreasers are sometimes used, though the hot vapor is apt to remove the impregnant from the surface porosity, partly destroying the seal. The solvent cleaner should be similar to hydrogenated naphtha and should be in motion.

Baking or curing can be done in three ways: (1) Under pressure of carbon dioxide, nitrogen or air; (2) in hot mineral oil or (3) in a conventional hot air oven. By the first two there is no surface exudation of the impregnant, but after hot oil baking one must clean again. Recommended is a bake for 40 min. at 275 F., followed by a 50-min. bake at 325 F. During the first period the impregnant is converted to a solid gel, so there is no danger of losing monomeric styrene at 325 F. later.

No. 988 forms cross linkages between the styrene and resin molecules during baking, causing the solution to go from a thin liquid to a gel state. The impregnant becomes "frozen" in the pore and can't thereafter ooze out. The styrene does a twin act of serving as solvent and converting to the copolymer formed with the No. 988 resin. Hence there is no subsequent "solvent" loss on baking. The only possible loss is from the styrene before complete polymerization takes place. But if castings are polymerized under 90 lb. air pressure this loss has been found by tests to be under 0.5%.

Characteristics of the Compounds

Though the composition of No. 988 is not revealed by its makers, it is known that such resins are usually made from glycerine, phthalic anhydride and oil fatty acids (from linseed oil, coconut oil, etc.). No. 988 is described as a non oxidizing synthetic resin with excellent storage stability. While monomeric styrene is reactive, it is stabilized by the manufacturer for a prolonged period. The mixture of the two is reactive, but stable enough for normal factory working cycles. Samples kept at 68 F. have been stable over three months. Since a factory impregnating tank is cooled and is given daily additions of fresh material, stability is perpetuated. Where warm castings are immersed in the tank water cooling of the tank at 65 to 70 F. is advised.

After the processing the completely cured copolymer that has been formed is found satisfactorily resistant to high octane gasoline, hot motor oil and other fluids used in airplanes. It will retain sealing efficiency under operating conditions up to 350 F. for prolonged periods.

Ault & Wiborg have used in their development work and testing monomeric styrene produced by Dow Chemical Co., a product that has been suitably stabilized. But any other accredited manufacturer's product is acceptable. The stabilized monomeric styrene is a clear water-like liquid, weighing 7.5 lb. per gal., with boiling point of 293.5 F. and flash point at 87.8 F. Storage tanks or working equipment should not contain copper or brass since they are reactive with the styrene, forming a compound that may interfere with the polymerization of the impregnant. Bare iron or tin-coated metal may be used.

Dow is the only independent producer of monomeric styrene. Before the war this was used to make polystyrene, a plastic molding powder. Since the war

they have produced the styrene largely for synthetic rubber. By itself the styrene was found too volatile in the monomer stage and, as polystyrene, was thermoplastic as well as soluble in gasoline.

When the resin and styrene are mixed there is a cross linking of molecules of the two substances, forming a single molecule during curing that has properties of its own, separate and different from either the properties of the resin or the styrene molecule. The secret of the penetration into the castings' pores are the low viscosity and small molecular size of the impregnant.

The ideal impregnating material would possess the following ten attributes: Thermosetting behavior (infusible on reheating), gasoline insolubility, low viscosity in the monomeric state, chemical inertness toward magnesium, proper temperature polymer-chain-length relationships, faculty of plasticizing to avoid formation of brittle glassy polymer, slight expansion on polymerization, non-toxicity, availability from both the economical and strategic standpoints and good penetrating properties. Apparently the A. & W. product fulfills these requisites reasonably well.

Tests on Magnesium and Other Materials

Here are some tests of the Ault & Wiborg product by a certain builder of aircraft engine parts and other equipment made of cast iron, the tests having been conducted at 170 p.s.i. air pressure. An engine casting impregnated once, still leaked; treated twice, was okay. A filter body proved okay, when treated twice, or only once. Other castings made of "Zamak" (zinc alloy) tested as follows: An indicator body was okay with two, and even one impregnation. Another part leaked with one impregnation, but held with two. Another part was okay with one treatment.

At the same plant aluminum valve bodies that were extremely porous at 100 p.s.i. air pressure were impregnated once, then twice and both passed the test at 175 p.s.i. air pressure. Testing officials concluded that the "method is satisfactory provided these castings are impregnated twice to insure perfect sealing."

Another prominent company reported experiences with ten magnesium castings that had been rejected as leakers. After impregnating treatment they were tested for leaks under water at 40 p.s.i. and found to be 100% pressure tight.

Fig. 5. Tests for (left) compatability of ingredients of No. 988 compounds and (right) reaction to high-octane gasoline exposure. A description of these tests appears in the text.

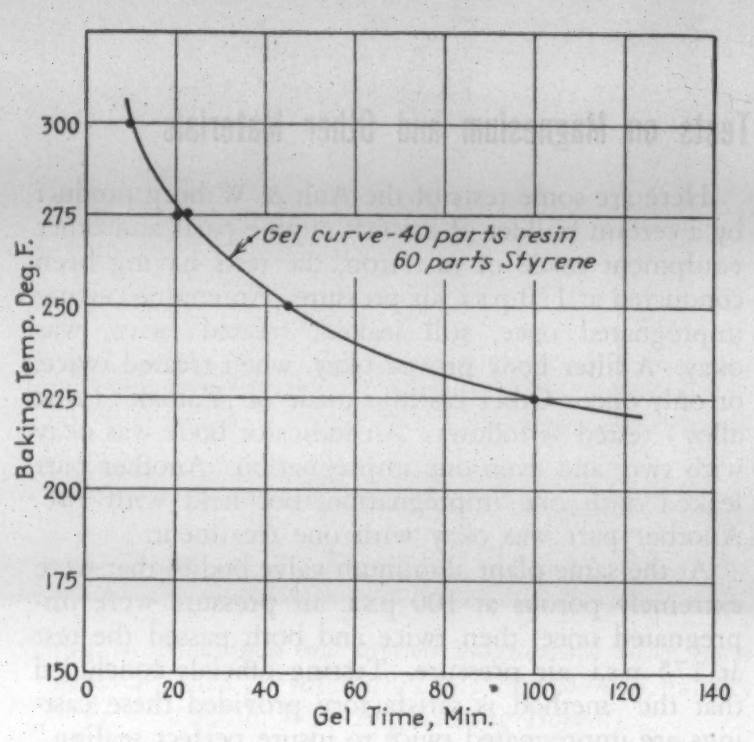


Fig. 6. This "gel curve" of No. 988 was made with 40 parts resin and 60 parts styrene in the Ault & Wiborg laboratories. Tests were on 8 gm. samples in an open test tube, tested in an oil bath. Briefly, the sample converts from a liquid to a solid in 10 min. at 300 F.; in 22 min. at 275 F.; in 45 min. at 250 F. and 100 min. at 225 F.

Because of the newness of the product not enough experience has been accumulated to enable the writing of a "last word" article on this subject. An engineer is a most thorough sort of individual and he leans over backward before committing himself to something new. Should we have waited for final and all-out tests we should have lost the timeliness of this article. Sufficient to say that, based on the reputation of the manufacturers, the printed confidential reports and grapevine reports that have come to our ears, this description of the Ault & Wiborg product has been justified.

For preparation of test impregnations there has been developed a laboratory impregnating set-up, shown in an accompanying photo (Fig. 2). The large pressure tank is installed in an ordinary box type gas heated oven. Castings are placed in the tank, the lid fastened, the pump then pulling a vacuum of 27 in. of mercury and held for 15 min. The impregnating solution is sucked into the tank, covering the castings. Then pressure is applied on top of the liquid for a few minutes. The castings are taken out and cleaned. The solution is drained from the tank and pipes to prepare for baking. The castings are placed back into the tank, the lid fastened, 90 lbs. pressure applied and oven doors closed. Heat is turned on for the prescribed baking schedule.

The tests for compatability, some results of which, are shown in one of the illustrations, are also of interest. Referring to this photo (Fig. 5). In the case of the No. 988 compound the same volume of resin remains after baking as before and the cured copolymer is transparent except for light refraction lines. Experiments with sodium silicate and a phenolic resin organic solvent solution, both of which contain less than 50% resin forming ingredients, show that after baking, ingredients in the test tube shrink 50% from the original volume. Transparency after baking proves the compatability of the constituents of the mixture. Experiments with linseed oil-styrene solution (which antedate the A & W process) show a turbid and cloudy solution after baking, indicating incompatibility of ingredients.

The jar at the right in Fig. 5 represents the solubility test, the No. 988 having been immersed in high octane gasolene. Similar tests with linseed oil-styrene-benzoyl peroxide revealed complete disintegration. A comparison of the above two as to thermoplasticity consists in baking each sample in a test tube for 2 hrs. at 275 F.; then inverting at a 45 deg. angle and heating to 325 F. for 1 hr. The No. 988 remains completely in the tube whereas the linseed oil-styrene-benzoyl peroxide oozes out to the extent of perhaps one fourth of its contents. The practical application would be in a casting which must withstand rather high temperatures.

Other Impregnators and Equipment

Doubtless there are other similar products that are worthy of consideration, but are too new, or facts not yet sufficiently correlated, to be treated here. There has come to our attention, however, the Bakelite sealing solutions, made by Bakelite Corp., 30 E. 42nd St., New York. They are of two types. Their BE-2106 contains a filler that prevents shrinkage, recommended for most castings where porosity is somewhat open, particularly in aluminum castings. BV-1845 is a thinner solution for castings where porosity is fine, including nickel, silver, bronze and brass. Of course they are not intended to seal castings containing large blow holes, sand holes and certain mechanical defects such as cracks.

One of the autoclaves used in treating porous castings is that made by Jackson & Church Co., Saginaw, Mich., equipment that has several other uses than with metals.

An Addition to the Powder Metallurgy Manual

Through a virtually unforgivable error on the part of your editors Table II on page 1341 in the Appendix to the Powder Metallurgy Manual in our November issue did not indicate the products made by one of the leading manufacturers of powder metallurgy parts, Powder Metallurgy Corp. of Long Island City, N. Y. The omitted information is presented herewith, and readers are requested to locate their November issues and add the word "Pomet" in the fourth column of Table II, opposite each of the Applications or Products listed below.

The parts and products made by Powder Metallurgy Corp. should have been given as follows (the numbers are those used in our original tabulation):

9	Corrosion Resistant Parts or Claddings	18	Magnetic Cores
17	Machine and Ordnance Parts	23	Pole Pieces
		26	Seals, Retainers, Spacers, etc.

Our apologies are offered both to the Powder Metallurgy Corp. and our readers for this unfortunate omission. —F. P. P.

METALS and ALLOYS

Engineering File Facts

NUMBER 66
December, 1944

MATERIALS AND DESIGN
Magnets

Permanent Magnets

One of the distinguishing properties of a small group of metals is magnetism. Iron exhibits this property most strongly, nickel and cobalt less so. However, a group of special alloys, some of the constituents non-magnetic under ordinary conditions, can be prepared with considerably greater magnetic force than pure iron.

Those materials that tend to retain a large part of the magnetism induced in them are said to be hard magnetic materials. These include the permanent magnets. The relationship between induced or retained magnetism and the magnetizing forces is known as *coercive force,* and is one of the most important characteristics of magnetic materials. Coercive force is expressed in *oersteds,* which is magneto-motive force (in *gilberts*) per cm.

Permanent magnets have been so increased in efficiency in the past few years that they are replacing electromagnets in some devices. The materials used are of four general types, *i.e.,* Alnico, chrome magnet steel, tungsten magnet steel and cobalt magnet steel.

Alnico is the name used to designate a group of alloys of iron, aluminum and nickel, with cobalt and copper added in some grades. All have high coercivity. A standard composition is 63 Fe, 20 Ni, 12 Al, and 5% Co. A composition for Alnico is given as 63 Fe, 25 Ni, and 12% Al. A composition containing all five metals, with 23 Co, 15 Ni, 3% Cu, and between 5.7 and 16.6% Al, with iron the remainder, was developed in Germany several years ago, and the alloy with 8 to 10% Al is reported as having the highest coercivity of any yet developed.

The Alnico preparations are comparatively weak, brittle, unmachinable (except for one grade, machinable with difficulty), and may be produced either as a cast form or as a sintered product. The latter process is generally more economical for magnets weighing less than 0.1 lb. Since the material cannot be reformed, it must be produced in the final shape. It has a density of about 0.25 lb. per cu. in. The alloy has more available stored energy per unit volume than any other permanent-magnet material.

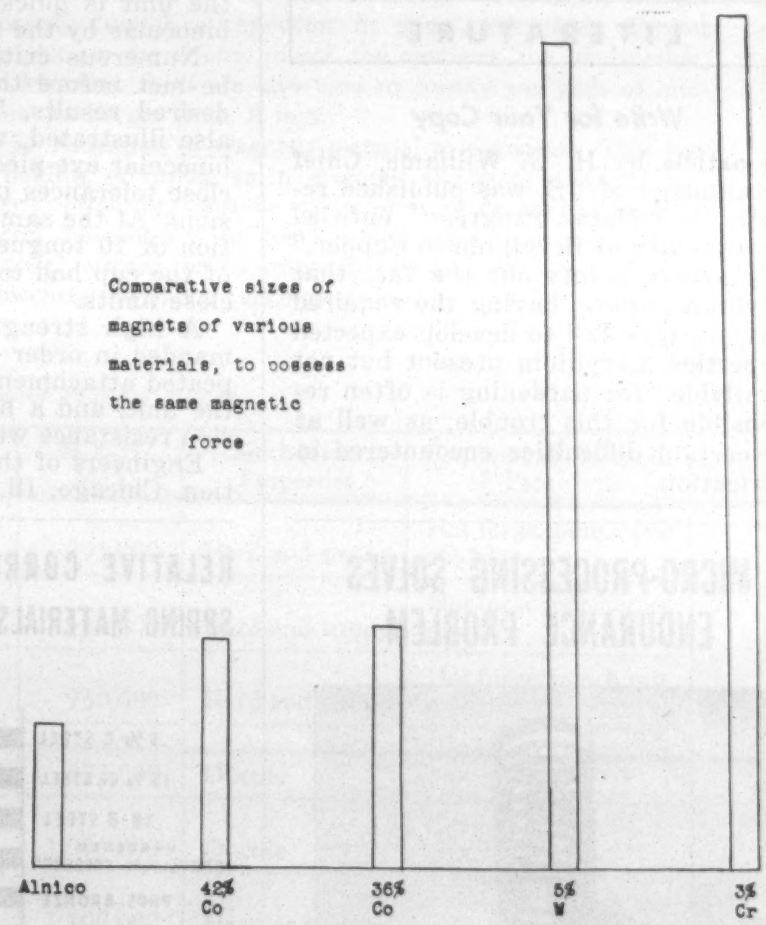
Chromium magnet steels will usually contain about 0.90 to 1.00% C, 3 or 4% Cr, and possibly small amounts of some other alloying element, as silicon or manganese. They may be formed from rolled stock, or cast to shape. They are machinable in the annealed state, but are used in the quenched condition.

Tungsten magnet steels, like the chromium types, can be made from rolled stock or cast to shape, and are machinable when annealed. They may contain 5 or 6% W, about 0.50 to 0.75% C, and in some cases silicon, manganese, chromium, or other element.

The *cobalt magnet steels* usually have a much higher alloy content than magnet steels of other types. The steel may be named by cobalt content, as 3%, 6%, and so on to 35% or more of cobalt. Carbon content may be of the order of 0.90 to 1.00%, and frequently the composition will include several per cent of chromium, tungsten or molybdenum, and possibly smaller amounts of manganese or silicon. Some compositions are prepared as castings; others can be formed from rolled stock. Most of the highly alloyed materials are difficult to machine. While the magnets are used in the quenched condition, a few alloys are hardened in air.

Alnico magnets resist demagnetization at elevated temperatures better than other permanent magnet materials. There is little loss of magnetic force at temperatures up to 925 F., while with the cobalt or chromium magnet steels appreciable losses occur at temperatures as low as 200 to 400 F. Vibration also is less demagnetizing to Alnico than to other magnets. Exposure to stray magnetic fields demagnetizes Alnico less than the alloy steel permanent magnets.

All permanent magnets are used in connection with an air gap. The gap may be fixed as in electric meters, or variable, as in thermostats.



Magnetizing may be done by two methods: (1) By the use of an electromagnet, the demagnetized magnet being placed in contact with the proper pole pieces while direct current is applied to the electromagnet. (2) By means of impulse, in which one or more conductors capable of carrying the required current are passed through the magnet opening. In built-up structures having a magnet with soft iron pole pieces, the conductor is wound around the magnet and direct current passed. Several pieces may be magnetized simultaneously.

Permanent magnets are sometimes shipped in a demagnetized state, to be magnetized before being put into service. Alnico

(Continued on page 1637)

The I-S SPRINGBOARD

VOL. 1 NO. 2

Published by INSTRUMENT SPECIALTIES CO., INC.

224 BERGEN BOULEVARD — LITTLE FALLS, NEW JERSEY

FILEWORTHY FACTS ABOUT MICRO-PROCESSED BERYLLIUM COPPER

NEW I-S PROCESS FOR SPIRAL BRUSH SPRINGS

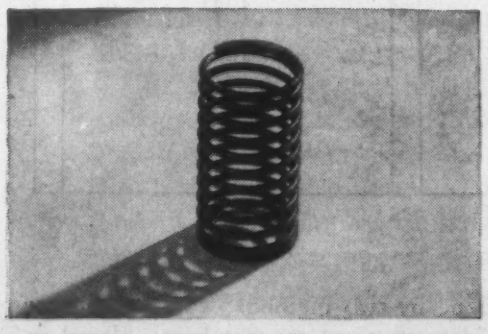
Instrument Specialties has recently perfected a new method for making spiral springs used for motor brushes. These springs are produced with uniformly concentric coil; the angle between ends being held to close tolerance. More information will be detailed in a later issue of "The Springboard."

LITERATURE

Write for Your Copy

An article by H. G. Williams, Chief Metallurgist of I-S, was published recently in "Metal Progress" entitled "Availability of Beryllium in Copper." This article points out the fact that beryllium-copper, having the required analysis, may fail to develop expected properties. Beryllium present but not "available" for hardening is often responsible for this trouble, as well as for certain difficulties encountered in fabrication.

MICRO-PROCESSING SOLVES ENDURANCE PROBLEM

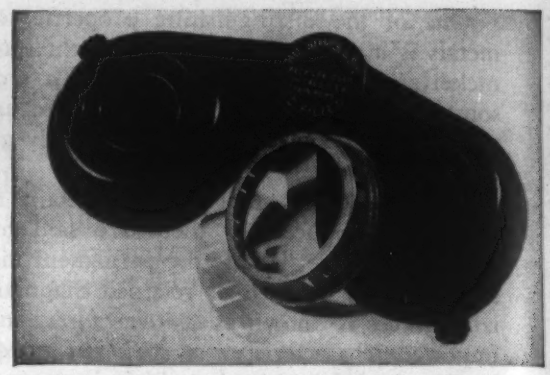


A Sensitive Control device required a spring produced to relatively close tolerances, and calibrated after assembly. Elimination of drift was essential, to maintain initial calibration. Also, the control device had to be designed to withstand rapidly repeated load cycles in a corrosive atmosphere.

Micro-Processed Be Cu, as shown in the chart at the right, offered a design solution meeting all performance requirements. The I-S Spring developed for this application (see illustration) required considerably less space because of higher safe working stresses.

ONLY BERYLLIUM COPPER^{mp} MEETS REQUIREMENTS OF BINOCULAR FILTER PART

Beck-Lee Design Made Possible by Using Beryllium Copper to Fullest Potentialities



The Glasser Filtrol binocular attachment shown here is a removable variable density filter which makes it possible to spot airplanes when looking directly into the sun. As the plane leaves the sun, the filter can be adjusted instantly to give less filtering, and as the plane leaves the sun area entirely and no polaroid is necessary, the unit is quickly flipped off of the binocular by the user.

Numerous critical demands had to be met before the unit would assure desired results. The drawn cup part also illustrated, which snaps over the binocular eye-piece, had to be made to close tolerances in all physical dimensions. At the same time the spring action of 10 tongues formed in the side of the cup had to be controlled within close limits.

A high strength material was demanded in order to withstand the repeated attachment and detachment of the unit, and a high degree of corrosion resistance was essential.

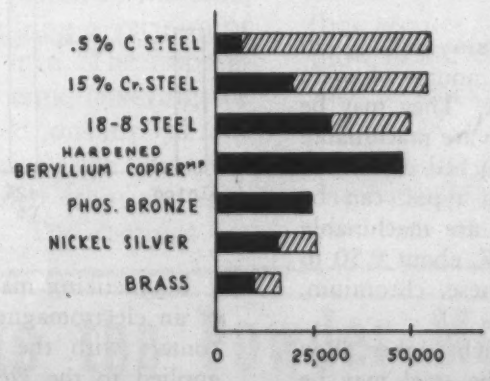
Engineers of the Beck-Lee Corporation, Chicago, Ill., knowing the possibilities inherent in Beryllium Copper^{mp}, with the assistance of the I-S engineering department developed the design to be micro-processed from specially annealed strip, formed while soft, and heat treated to obtain desired constant spring properties.

A special annealing technique was developed by Little Falls Alloys, suppliers of the strip, to provide a material having the necessary ductility together with full hardening response . . . in effect a "soft hardening" process.

To hold the attaching pressure with the desired limits, the individual spring tongues are heat treat formed.

This is a typical example of the exceptional accomplishments possible when the full potentialities of Be Cu^{mp} are applied to a difficult problem.

RELATIVE CORROSION-FATIGUE OF SPRING MATERIALS UNDER SALT SPRAY



Many materials that show good endurance life under normal alternating stress lose that advantage under corrosive conditions. The above chart shows the endurance limit of several spring materials at 50,000,000 cycles. The cross hatched area being the loss in endurance life when the test is repeated under salt spray. Note that only beryllium copper and phosphor bronze retained their full endurance strength under this corrosion-fatigue test.

FROM THE I-S LABORATORY

SPOT WELDING BERYLLIUM COPPER

Beryllium copper springs are spot welded easily, but the welding operation reduces the strength of the material at the point of the weld. To minimize the area of weakness, it is advisable to spot weld with a short time cycle. In general practice, it is preferable to weld after hardening, since it is difficult to heat treat the welded assembly.

The shear strength of heat treated beryllium copper is 95,000 psi, while some measurements of the shear strength of spot welded points indicate a shear strength of 64,000 psi (this latter figure can be raised to 73,000 psi by proper heat treatment after welding).

This lowering of peak strength by spot welding makes it impossible to take full advantage of the high spring properties of beryllium copper if the welded area is at the point of peak stress concentration. It does make possible, however, the spot welding of contacts on the end of cantilever springs where the stress is lower.

magnets require a considerably stronger magnetizing force to energize them completely. At least 2000 oersteds (4040 ampere-turns per in. of length) are required. Values for other magnetic materials are:

Magnetic Material	Minimum Value to Saturate	Equivalent Ampere-turns per in.
Chromium steel	300 oersteds	510
Tungsten steel	300 oersteds	510
Cobalt steel	1200 oersteds	2440
Alnico, several grades	2500-3000 oersteds	5100-6350

The source of the current may be a large direct current generator, an impulse transformer, storage batteries, a half-cycle magnetizer, or the discharge from a condenser. The time cycle can be very short.

After being magnetized, the permanent magnets should be protected from contact with one another, or with other magnetic materials.

When a permanent magnet is to be designed for a particular application, one of the first problems is the solution of a magnetic circuit. This may be approached by determining the size, shape and material of a permanent magnet that will produce a certain desired flux in an air gap, or in some other part of the magnetic circuit; or the flux produced by a magnet of fixed size, shape and material may be determined.

Uses of permanent magnets will fall into three groups:

(1) Production of electrical energy, for which the permanent magnet creates a magnetic field, while mechanical motion of a conductor in the field produces the electrical energy. The conductor may be located on a rotating armature, as in the familiar generator, or it may be on a stationary winding, with rotating magnets. Conductors moving in the magnetic field by vibrations in the air illustrate the principle of the dynamic microphone. In the phonograph pick-up, the magnet acts as a polarizing agent; as the reluctance of the magnetic circuit is varied mechanically, the amount of flux through the coil is varied, producing electricity.

(2) Production of mechanical energy—an electric current is passed through a conductor in a magnetic field. Typical examples are the electric motor, the ammeter, the loudspeaker, etc. Magnetic fields are also used to control the path of electronic discharges from X-rays.

(3) Attraction of magnetic material to a magnet. This may be holding or lifting, as in magnetic chucks or magnetic separators; producing tension, as in pressure or similar types of control instruments; or for a quick make and break in an electrical circuit; or to transmit motion without mechanical connections, as in the packingless drive.

Properties of Commercial Permanent Magnet Alloys

Alloy	Typical Composition Per Cent	Coercive Force (H)	Residual Indn. (B)	B X H Max.	Mechanical Properties	Commercial Methods of Fabrication
Chromium magnet steel	3.5 Cr, 1 C, bal. Fe	63	9,000	295,000	Hard and strong	Hot forge, punch and machine
Tungsten magnet steel	5 W, 1 C, bal. Fe	70	10,300	320,000	Hard and strong	Hot forge, punch cast, machine
Cobalt (36%) magnet steel	36 Co, 3.5 Cr, 1 C, bal. Fe	210	9,000	930,000	Hard and strong	Hot forge, punch cast, machine
Cobalt-nickel copper alloy	41 Co, 24 Ni, 35 Cu	440	5,300	993,000	Ductile	Cold-roll, machine, punch cast
Iron-nickel copper alloy	20 Fe, 20 Ni, 60 Cu	450	5,300	1,070,000	Ductile	Cold-roll, machine, punch
Comol magnet alloy	12 Co, 17 Mo, bal. Fe	245	10,300	1,100,000	Hard and strong	Hot-forge, punch machine, cast
Alnico IV	12 Al, 28 Ni, 5 Co, bal. Fe	700	5,200	1,250,000	Hard and brittle	Cast, sinter, or grind
Alnico III	12 Al, 25 Ni, bal. Fe	400	7,100	1,330,000	Hard and brittle	Cast, sinter, or grind
Alnico I	12 Al, 20 Ni, 5 Co, bal. Fe	400	7,100	1,330,000	Hard and brittle	Cast, sinter, or grind
Alnico II	10 Al, 17 Ni, 12.5 Co, 6 Cu	540	7,200	1,650,000	Hard and brittle	Cast, sinter, or grind
Alnico V	8 Al, 14 Ni, 24 Co, 3 Cu, bal. Fe	525	12,000	4,000,000	Hard and brittle	Cast, grind

Taken from an article by J. H. Goss in the April 1942 issue of METALS AND ALLOYS

Prepared by Kenneth Rose, Engineering Editor

OLSEN *Torsion* TESTING MACHINES

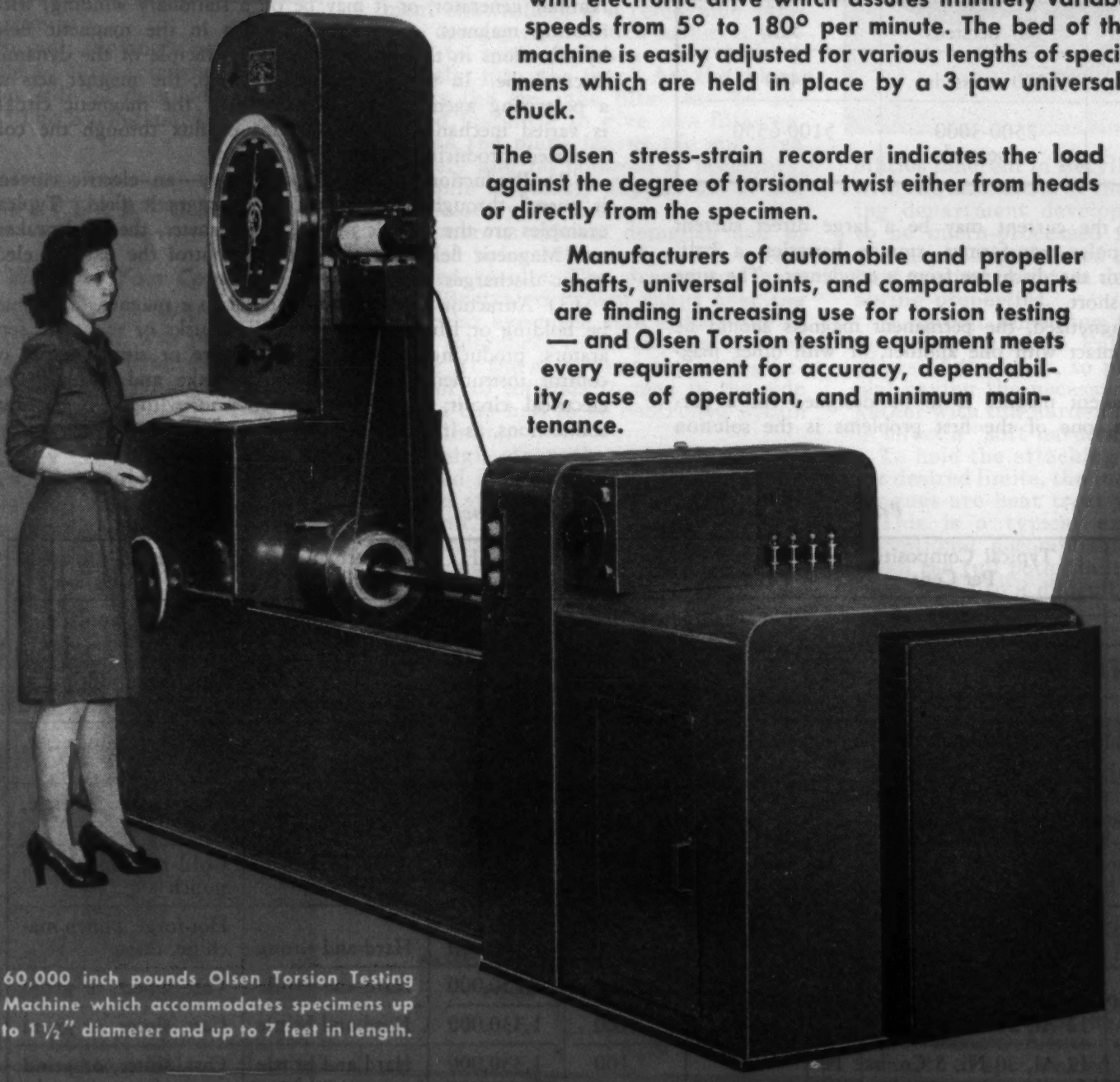
with AUTOGRAPHIC RECORDER

So simple to operate, that the girl performing the torsion test shown turns but a single control knob — and the test results are simultaneously dial indicated and transcribed on the recording chart!

Olsen Torsion testing machines, in sizes ranging from 500 inch pounds to 1,000,000 inch pounds, employ a lever mechanical weighing system with electronic drive which assures infinitely variable speeds from 5° to 180° per minute. The bed of the machine is easily adjusted for various lengths of specimens which are held in place by a 3 jaw universal chuck.

The Olsen stress-strain recorder indicates the load against the degree of torsional twist either from heads or directly from the specimen.

Manufacturers of automobile and propeller shafts, universal joints, and comparable parts are finding increasing use for torsion testing — and Olsen Torsion testing equipment meets every requirement for accuracy, dependability, ease of operation, and minimum maintenance.



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METALS and ALLOYS
Engineering File Facts

NUMBER 67
December, 1944

METHODS AND PROCESSES
Heat Treating

Special Purpose Atmospheres

In *Engineering File Facts* No. 62 there was given a brief outline of the types of controlled atmospheres used for the protection of steel. This number continues with the prepared atmospheres, used with steel for purposes other than protection of the metal, and with those used for metals other than steel. As in the preceding number, only gaseous atmospheres are considered. Many are identical with those already described, and these are mentioned only by type, since compositions were given in the prior Data Page. Since such case hardening methods as gas carburizing and nitriding were described in *File Facts* No. 2, these are here mentioned from the standpoint of atmospheres used.

Non-ferrous Protective Atmospheres

The non-ferrous metals can usually be heated for fabricating or heat treatment without any special atmospheres. However, when finished or semi-finished parts must be annealed, it is sometimes desirable to protect them in the same manner as steel. This is especially true of copper.

Copper, especially tough pitch, has been annealed in an atmosphere of steam. In this case the steam serves principally to exclude oxidizing gases. Illuminating gas is sometimes added to "sweeten" the steam. Because of difficulty with water-staining of the metal as it cools, steam is not used as extensively as formerly.

Copper and brasses can be clean annealed in atmospheres of completely burned fuel gas. Atmospheres of charcoal gas, composed of about 28% CO, 0.5% CO_2, balance N_2, are similarly used.

In casting copper parts for certain types of vacuum tubes, where gases must be excluded to the greatest possible extent, a very high vacuum is used. Vacuum casting of copper was used in prewar Germany also, in the preparation of ingots of very high purity. Batches were of about one-half ton each.

Oxygen-free, high conductivity copper may be annealed in the charcoal gas atmospheres referred to above. Especial precautions are taken to exclude hydrogen, hydrocarbons, water vapor, and oxidizing components. Sulphur must be held to the lowest possible limits for all atmospheres intended for use with copper.

Nickel silver alloys (copper-nickel) can be bright annealed in an atmosphere of completely burned fuel gas, provided sulphur is absent.

Copper-silicon alloys can be bright annealed in completely burned, scrubbed, fuel gas atmospheres free from sulphur.

Nickel and nickel alloys require no specially prepared atmospheres. Control of combustion so as to keep a slight excess of fuel over air is all that is needed under ordinary conditions. Sulphur should be carefully excluded. A CO content of 2% or higher is common, and, since the metals are not subject to carburization, there is no upper limit. When a bright surface is required on finished work, dissociated ammonia or burned dissociated ammonia should be used.

Inconel, a nickel alloy containing chromium and iron, can be bright annealed in an atmosphere of dissociated ammonia or burned dissociated ammonia.

Lead is not given any atmospheric protection in most operations. The use of an atmosphere of CO_2 to exclude oxygen has been adopted in the forming of lead sheathing for electric conductors.

Aluminum is fabricated and heat treated without the use of any prepared atmosphere. When heat treating finished or semi-finished work at high temperature, as in the solution treatment, the metal should not be exposed directly to the products of combustion. This is especially true of the alloys 24S, 75S, and 14S. Indirect heating, with the work in ordinary air, is the usual method. Moisture content should be kept low.

Magnesium is commonly heat treated in air, preferably by indirect heating. For some parts a small quantity of sulphur dioxide, say about ½%, may be added for greater protection.

The metal when melted for casting is usually shielded by sulphur dioxide gas, used over the molten material as a blanket.

Powder Metallurgy Operations

For reduction of metal powders, hydrogen is the most common reagent. It is an advantage, therefore, to have a protective atmosphere rich in hydrogen for reduction and sintering procedures. These atmospheres are of three types:

(1) Pure hydrogen. Gas supplied from a hydrogen generator, or as bottled gas.

(2) Dissociated ammonia. This atmosphere makes available a gas that is 75% H, the balance inert nitrogen. A dehydrating procedure is usually necessary in connection with commercial anhydrous ammonia.

(3) Reacted fuel gas, either city gas or natural gas. The resulting atmosphere is about 35 to 40% H.

Furnace Brazing Atmospheres

When work is to be brazed in large lots, without discoloration, the operation may be done in a protective atmosphere. For non-ferrous metals, usually copper or brass, a completely burned fuel gas provides a suitable atmosphere. Sulphur must be removed if bright surfaces are required with copper. Partially burned fuel gas, or partially or completely reacted gas can also be used as non-ferrous brazing atmospheres.

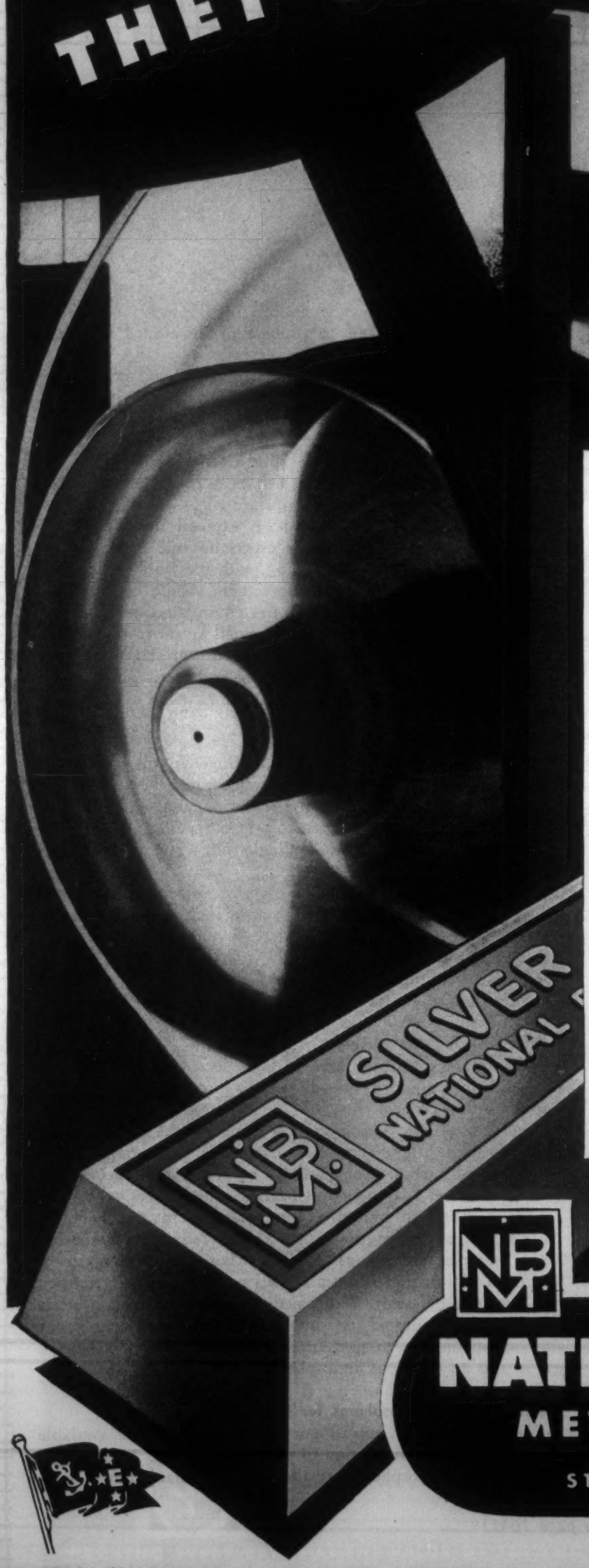
Steels are silver brazed at temperatures in the 1700 to 1800 F. range. Brazing with pure copper requires a somewhat higher temperature, about 2050 F. For low carbon steels, where decarburization is not a serious problem, partially burned fuel gas may be used. With medium and high carbon steels the partially combusted gas should be stripped of water vapor and carbon dioxide to prevent decarburizing effects. Charcoal gas is also an excellent atmosphere for such work.

Special Purpose Atmospheres for Steel

For use with steel, special purpose atmospheres are available for changing the composition of the metal surface. Most widely used of these atmospheres are those for case hardening.

(Continued on page 1641)

THEY SPIN—ON SILVER



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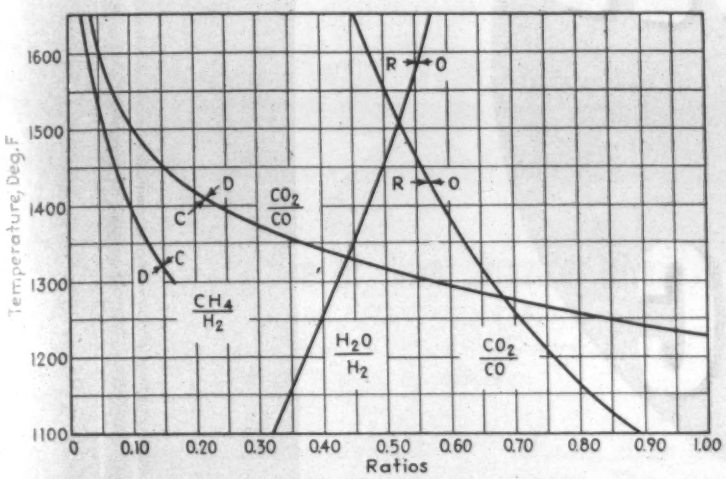
NUMBER 67 (Continued)

SPECIAL PURPOSE ATMOSPHERES

Gas carburizing makes use of the absorption of carbon by steel from carbon-rich gases, usually methane, ethane, propane, natural gas, city gas, etc. In actual operations, methane and ethane are usually supplied as natural gas, of which they are the most important constituents. The carburizing gases break down at high temperatures to liberate carbon. In preparing a carburizing atmosphere, a nice balance must be attained of the rate of breakdown of the carbon-rich gases, their concentration, the temperature of operations, and the rate of carbon diffusion into the steel under consideration at the temperature of operations. This becomes an adjusting of carbon pressure of the atmosphere in relation to the carbon pressure of the steel.



Equilibrium curves for oxidizing-reducing and carburizing-decarburizing effects in iron-carbon alloys saturated with carbon at temperature in question.

"Industrial Electric Heating," by N. R. Stansel; published by John Wiley & Sons, 1933.

Control of carbon pressures in the atmosphere can be had through varying the carburizing gas or gases used, adjusting the proportion of neutral gas (nitrogen or hydrogen, or even the slowly-reacting carbon monoxide) in the atmosphere or, occasionally, through the need to neutralize the decarburizing action of small quantities of carbon dioxide or water vapor. Methane breaks down most slowly of the carbon-rich gases. The heavier carburizers, such as ethane, propane, butane, etc., decompose more rapidly, and must be used in low concentration to avoid deposition of soot. Soot causes non-uniform case depth in the steel.

Carburizing atmospheres are prepared by (1) feeding a small amount of undiluted carburizing gas, as propane, into the furnace, with spent gas as diluent; (2) adding a carburizing gas to charcoal gas, prepared by passing air over heated charcoal in a separate generator; (3) a burned fuel gas-air mixture is passed over hot charcoal to reduce carbon dioxide and water vapor, and a carburizer added; (4) a gas-air mixture is cracked in an external retort, using either its own heat of combustion or externally supplied heat; (5) a gas-air mixture is fed directly into the carburizing unit, the resulting combustion removing the air.

It will be noticed that these atmospheres are, frequently, a carburizing gas and a carrier gas. The carrier gas may be one of the standard types of prepared atmospheres, preferably one in which decarburizing constituents, such as carbon dioxide and water vapor, are present in small quantity only or are absent altogether. The carburizing gas may be methane, usually in amounts not exceeding 2%, or one of the richer carburizers, as propane, usually in amounts under 1%. If decarburizing substances are present, the content of carburizer must be increased, and the amount of increase rises very rapidly as percentage of decarburizer increases.

Methane is especially favored as a carburizer because, carbon being liberated rather slowly, the rate of carburization can be closely controlled.

Nitriding. The process of nitriding requires an atmosphere of dry ammonia gas. At the temperature of the process (920 to 1200 F., with 960 to 975 F. most common) ammonia gas is decomposed in contact with steel, and the nitrogen at the moment of liberation (nascent) reacts with the special nitriding steels to produce a hard case that does not require quenching. Liquid ammonia is vaporized, dried, and fed into the nitriding chamber.

Carbo-nitriding. It is known that the surface produced by the process of cyaniding contains both carbides and nitrides, and carbo-nitriding was devised to prepare a similar case by gaseous methods. The atmosphere contains both a carbon-rich gas and ammonia, proportions varying according to the physical properties desired in the case. City gas, propane, etc., may be the carburizing gas.

Atmospheres for *recarburizing* of decarburized steel surfaces are gas carburizing atmospheres in which a very careful balance of carbon monoxide and dioxide, hydrogen, and water vapor is established. The carbon pressure is so adjusted as to be in equilibrium with the carbon pressure of the desired carbon content of the steel.

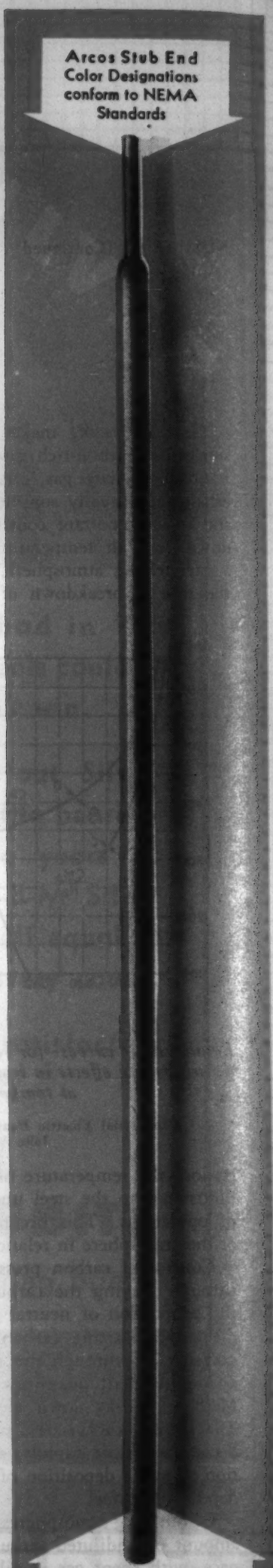
Bright gas quenching, in which a prepared atmosphere, cooled to low temperature, acts as the quenching medium for hardening steel, makes use of reacted fuel gas in present applications of this new method of heat treating.

Another recent use of a prepared atmosphere for a special purpose is in *gas pickling.* Especially adapted to such continuous operations as preparation of steel strip, the atmosphere used consists of a neutral or oxidizing gas containing about 10 to 30% hydrogen chloride, with water vapor excluded as far as possible. The atmosphere is prepared by burning a hydrocarbon gas, chlorine, and air, carefully proportioned so that water vapor is not an end product. As an illustration: $CH_4+2Cl_2+O_2 \rightarrow 4HCl+CO_2$. Natural gas or other hydrocarbon gas may be used similarly. In order to cool the gases and to increase their volume, they are diluted with an equal volume of dehydrated combusted gas before going to the pickling chamber.

Prepared by Kenneth Rose, Engineering Editor

"STAINLEND"

The ARCOS STAINLESS ELECTRODES FOR AC and DC



In 1937 Arcos developed the titania type of coating for AC welding with chrome-nickel electrodes. Until recently, Arcos had less confidence in the quality of the weld metal from the titania type electrodes than in the weld metal from the lime type (Chromend) electrodes. Arcos has now overcome the weld metal defects formerly encountered with the titania type of coating and offers with confidence its Stainlend type of electrodes for AC welding (suitable also for DC).

STAINLEND OR CHROMEND FOR DC?

When welding with direct current, the type of electrode (lime or titania) best suited for a particular job depends upon a number of factors. Contact your Arcos Distributor who will be glad to give you a definite recommendation to assist you in your decision as to whether Stainlend or Chromend should be used for DC welding.

Always specify Stainlend for AC welding. Samples are available on request.

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Chrome-Nickel and Straight Chrome Electrodes

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FOR HIGH TENSILE STEELS
Manganese-Moly Electrodes

FOR NICKEL, BRONZE, ETC. ALLOYS
Non-Ferrous Electrodes

METALLURGICAL ENGINEERING

shop notes

Use of Silver Brazing Wire

by Col. Harry R. Lebkicher, C.O.
Chemical Warfare Procurement Dist.
of Chicago

In the silver alloy brazing of gas mask parts occurs one of the best illustrations encountered of the capillary flow of such brazing alloys. Two 1-in. pieces of 1/16-in. brazing alloy wire melt when heated and are pulled by capillary action around the entire circumference of the joint between the body and the threaded ring and penetrate through the joint between

these parts to the inside of the joint, making a gas tight bond.

This work is done on the gas mask breather parts, made of 0.030-in. steel with about 0.002-in. copper clad on both sides. The threaded portion of the assembly is spot welded to the main body, locating these parts in their correct position. The gooseneck part of the assembly is clinched in place underneath. Then the parts are laid flat on a tray and the two pieces of brazing alloy placed beside the threaded stamping.

A hairpin-shaped piece of 3/64-in. wire is slipped around the base of the gooseneck. All of the brazing alloy wire is dipped in a thin solution of Handy flux. Eight of these assemblies, mounted on a tray, are put through a reducing atmosphere gas-fired furnace at 1500 F., being left there 4 min. About 40 units move through the furnace every 4 min. They emerge looking quite clean and requiring only washing to prepare for paint.

Spot Welding vs. Riveting

by George A. Fernley,
Resistance Welder Manufacturers' Assn.

In the manufacture of a seaplane mooring bit assembly, the adoption of spot welding in the place of riveting reduced the operation from 2½ hr. to ½ hr. at the Baltimore plant of the Glenn L. Martin Co. With the riveting, the attendant impact tended to distort the tube, which must be perfectly round to fit into the mooring bit socket on the plane. Substitution of aluminum rivets for steel did not help. All attempts to rectify distortion failed.

At length, spot welding was tried, when distortion was eliminated and the weld had four times the shear strength of an aluminum rivet. The job involved attaching a thick rough casting to a thin-walled tubing. Special electrodes and heat control sequence were necessary.

Stainless Steel Shot Blasting Pellets

by Harry A. Cooper,
Cooper Alloy Foundry Co.

Where cleaning and finishing of ferrous metal castings is done by blasting with steel shot, a fine deposit of steel dust that is worn away from the pellets deposits on the casting surface. For carbon or low alloy steel and iron castings this is satisfactory.

However, when a dust from ordinary steel is deposited on stainless steel, the surface is rendered subject to corrosive attack, thus destroying the primary property of the stainless alloy—its corrosion resistance. The Cooper Alloy Foundry Co., Hillside, N. J., developed a remedy by using shot, punchings or filings of stainless chromium-nickel steel for blasting and tumbling castings of similar compositions. They blast as effectively as ordinary steel, while the deposited dust is homogeneous with the casting material itself, hence equally resistant to corrosion. The process has been patented.

(Nickel Steel Topics, September 1944)

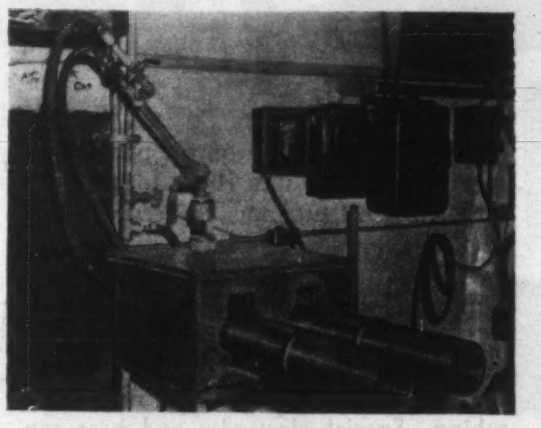
Homemade Oven for Preheating

by James Neary,
Tycoon Tackle Co. of Florida

A simple heat treat oven for preheating parts that are to be welded can be built easily by non-professionals by welding a double-walled oven from ¼-in. steel and attaching an air pressure gas cap. It can be set up in the welding department, where it heats the parts quickly and evenly so that the production welder does not have to wait for the heated parts.

This small oven was designed by the author, a welder at Tycoon Tackle Co. of Florida, for preheating inner and outer cylinders of certain airplane parts to 800 to 900 F. It eliminates the use of large ovens in the heat treating department.

The oven consists of a double wall lined with 1-in. asbestos sheeting all the way around. The box has a removable lid on which a fixture is welded so that an air pressure gas cap shoots a flame into the oven, hitting a square of fire brick. The oven, 24 by 24 by 18 in., is mounted on 1-in. pipe legs and is heated by city gas. It will "blue" two cylinders in 10 min.



The job, of which preheating is one step, consists of welding four different parts to form one aircraft assembly. Material is chromium alloy steel.

(Courtesy: Hobart Brothers Co.)

Adjustable Anodizing Racks

Information Submitted by
Glenn L. Martin Co.

Adjustable racks designed by employees of the finishing and plating department have almost halved the time of loading work for anodizing at Glenn L. Martin Co. The racks save electric current, since more parts can be placed in a tank at a time. The racks are simple and durable, and provide a sure and positive electrical contact.

Where the former spring hangers had to be cleaned after each usage and soon lost their temper and springiness, the new racks have an almost indefinite life, only the bottom frame needing cleaning. But since this frame is of straight rigid metal construction, it is easily cleaned and unaffected by the cleaning bath.

There are two basic types of rack, in several sizes, so that various sizes can be assembled for the job at hand. The first

consists of an aluminum alloy center post with a frame at the bottom on which parts can be stacked around the center post in log cabin style, with a pressure plate at the top to hold the racked work in place. Top edges of the bottom frame are toothed to keep the work from slipping. A spring and pin make the top pressure plate adjustable. The top of the center post is hooked for handling with an overhead conveyor.

The second type of rack has two posts, with a fixed channel section separating them at the bottom and a moveable section at the top. Both are toothed where they come in contact with the work. Parts to be anodized are loaded on the bottom section, and when the desired pile is built up, the top is clamped down to hold it in place similar to the single post racks.

In loading large parts that would smother one another, such as large corrugated sheets, smaller parts are used as spacers, thus utilizing plating solutions to their utmost.

In the first photograph parts are being unloaded from a single post rack. In the background are fully loaded racks, showing how parts are criss-crossed.

In the second photo stringers to be anodized are loaded in the second type

of rack. Because of the length of parts, two racks are used, with other smaller parts, also to be anodized, used as spacers.

Lithium Furnace in Aircraft Plant

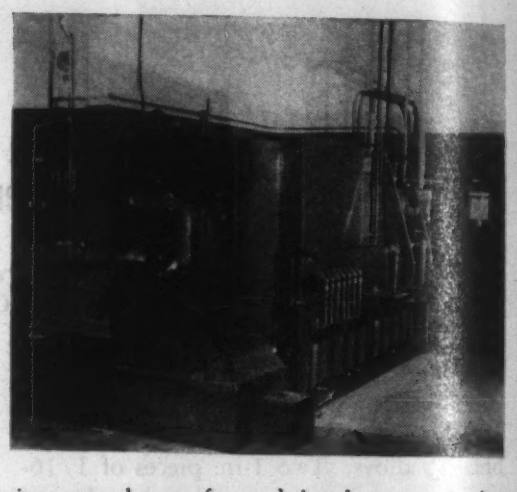
by Carl Bowen,
Lockheed Aircraft Corp.

For certain new airplane models, heat treating in the form of carburizing had to be performed, with the stipulation that there should be no scaling or pitting and that polish and lustre on parts remain the same after heat treating as before. After considerable research, the situation resolved itself into Lockheed becoming the first West Coast aircraft manufacturer to operate a lithium furnace.

The furnace uses natural gas of the Southern California Gas Co. It is put through a cracking process to eliminate nearly all moisture and then introduced into a lithium vapor, which has a high affinity for moisture. This eliminates existing oxygen, hence scaling.

The blanket of vapor covers the heat treating chamber and sends a curtain of vapor over the entrance, thus preventing outside air from entering when the furnace door is opened. Parts, when properly heat-treated, drop directly from the treating chamber into the oil bath quench without opening the charging door.

Both carburization and neutral harden-

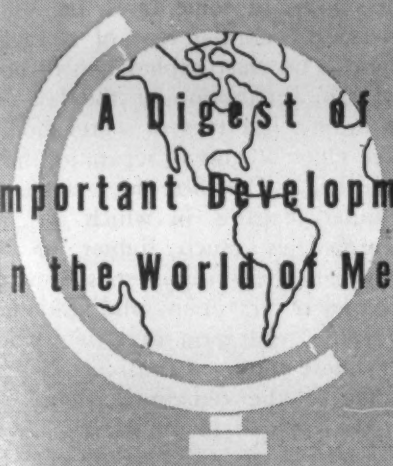


ing may be performed in the same unit. The change-over from one to another is done electrically. The muffle-type furnace was made by the Lithium Furnace Co., Newark, N. J.

For melting aluminum pigs we use in our foundry a battery of 19 Fisher gas furnaces. When the metal reaches 1200 F. a thermocouple is inserted and left pending correct pouring temperature. Formerly the couples were inserted and withdrawn by hand by an extension pipe handle. Since the furnaces are 5 ft. high the operator stood on a platform for this awkward and dangerous task. When not in use the thermocouple was laid on the floor where breakage was two per wk. per furnace. Then we devised a light jib crane of ½ in. round stock, attached to the furnace's canopy, reaching over the center of the pot, equipped with chain, two pulleys and counter weight. This device has saved $6000 per year in breakages and the operator is safe from falling bits of molten metal.

—Daniel Hart,
Packard Motor Car Co.

Metallurgical Engineering Digest



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1 Metal Production

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Segregation in Cast Alloys

Condensed from "Metals Technology"

Segregation in cast alloys can occur only when the composition solidifies over a range of temperatures with difference in composition of liquid and solid phases within this range. This condition is found in nearly all solid solutions or combinations of solid solutions and eutectics.

When solidification of an alloy over a range of temperatures is fairly rapid, metastable conditions of coring within solid solution dendrites results, with an associated abnormal enrichment in low-melting constituents of the final liquid to freeze. If the difference in composition between center and surface layers is of the same type as in coring, the first parts to freeze being richer in higher-melting constituents, the effect is called normal segregation. When what is apparently the first part of the casting to freeze shows a higher content of low-melting constituents, the effect is termed inverse segregation.

The dendritic type of solidification leaves channels that fill with the low-melting constituent, and so reduce, on a macro scale, the very large differences of composition found in cored structures.

Inverse segregation may result from the formation of internal gas bubbles, creating a positive pressure and forcing the low-melting constituent, now liquid, to the surface. Exudations may be formed under extreme conditions.

Another consideration is the contraction and the low-pressure areas in interdendritic channels associated with it. In connection with this must be considered segregation in the liquid phase, in which there is an enrichment in lower-melting constituents at the solid-liquid interface.

The flow of enriched liquid through the channels may, in some cases, be sufficient to reverse the normal type of segregation, but there is no clear explanation of how to control the distribution of the last liquid to freeze, or of the type of segregation.

Three types of gravity separation may be distinguished. The first is a segregation upon quiet melting, in which the liquid first formed is much lighter or much heavier than the solid crystals remaining. The second occurs upon solidification, and involves the separation of a few primary crystals whose density is considerably greater than that of the remaining liquid. The third type is found in monotectic alloys in which the two liquids are of markedly different densities. Alloys of this type are particularly well adapted to fabrication by powder metallurgy methods.

—R. M. Brick. *Metals Technology*, Vol. 11, Sept. 1944, pp. 3-12.

Steel Plant Instrument Maintenance

Condensed from "Iron and Steel Engineer"

In the steel plant, the organization taking care of maintenance of instruments and controls should be entirely separate from any operating division of the plant, and should be associated with either the maintenance, fuel or steam departments.

This maintenance group should specify the instrument and control equipment for new installations and should direct its installation. Some important points to observe include installation of impulse lines to controls and instruments so that they will collect a minimum of dirt from the equipment to which they are connected, provision for the easy removal of the dirt that does accumulate, and proper protection of the thermocouple and other temperature-measuring devices from mechanical injury.

Other points are: provision for properly cleaning the operating medium for controls; filters for compressed air, water, or oil to prevent foreign matters being carried into the pilot valves and cylinders; cabinets where needed for protection from dirt; protection from freezing of meters and impulse lines, where filled with water; and following the

● Efficient, economical fettling of an electric furnace calls for a smaller-sized refractory than the standard open hearth clinkered dolomite. Syndolag was designed to meet that need. It is a rice-size material, of sharp angled grains, carefully proportioned as to size and free of fines.

Since its introduction in the rice-size two years ago, Syndolag has grown steadily in favor in electric furnace shops. Operators who use it like it for these unique properties:

1. Sharp angle of repose—The small, angular grains stay in place well on steep slopes, instead of rolling down the banks to pile up around the edges of the flat. This cuts down fettling time, reduces refractory consumption and protects the capacity of the furnace.

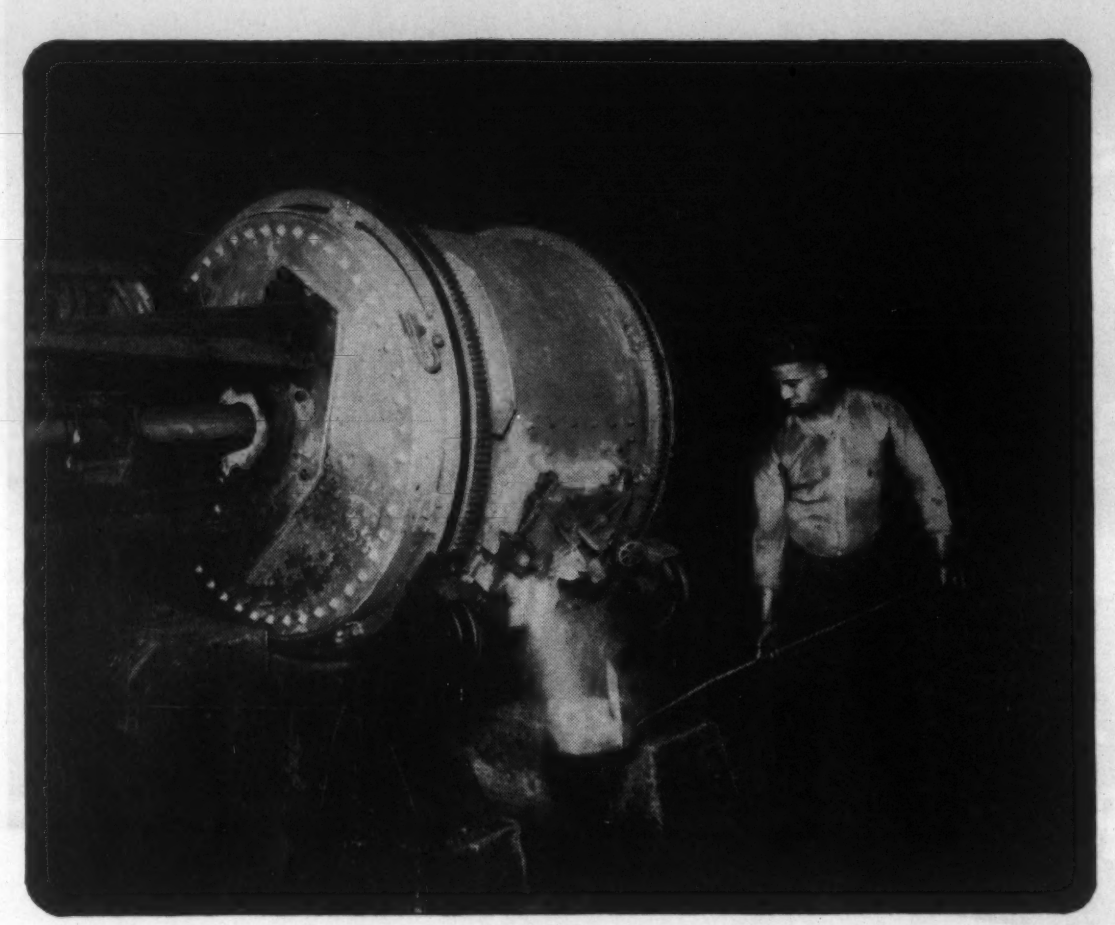
2. Rapid heat absorption—Small grains absorb heat more quickly than larger grained material. This is especially important in the electric furnace where only residual heat after tapping is available to set a refractory.

3. Quick consolidation—Syndolag's small grains set up quickly into a dense, homogeneous patch which does not cut out readily or loosen easily—a valuable asset for top charged furnaces.

Syndolag has the same desirable chemical and mineralogical properties that have made Magnefer so successful for open hearth maintenance. Both refractories are produced at our modern plant in Northwestern Ohio, located near the geographical center of the steel industry. Adequate stocks are maintained, so that we can take care of your immediate needs with prompt rail shipments.

BASIC REFRACTORIES, INCORPORATED *Cleveland, Ohio*

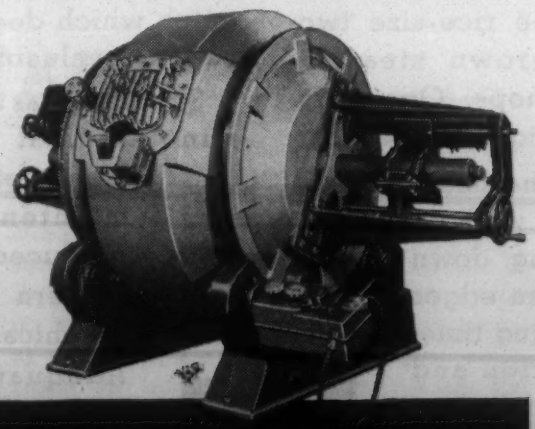
Postwar production will demand speed, quality and economy—Detroit Electric Furnaces give you all three



SPEED: Detroit Rocking Electric Furnaces give faster melting and more pounds per man hour. They melt as many as eight ferrous or sixteen non-ferrous heats in one 8-hour day—and each heat may be of an entirely different mix if desired.

QUALITY: Because of their automatic stirring action under non-oxidizing conditions—and because of their precise control over time, temperature and composition—Detroit Furnaces assure superior metallurgical results.

ECONOMY: Detroit Furnaces insure lower metal losses, less machine shop scrap, better machinability and a higher percentage yield of perfect castings of uniform quality. Versatile, flexible and fast, the Detroit Rocking Electric Furnace has proven itself to be the most efficient foundry melting unit for the widest variety of metals and alloys. Available in sizes from 10 lbs. to 4 tons.



DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

of research up to date show no difference either in physical properties or in cleanliness.

In the basic process, there is a distinct advantage in furnace bottom maintenance as there is 60% less silicon in the graphite charge. Phosphorus also amounts to less than 50% of that in the conventional charge. Therefore, fluxes can be reduced about 75%.

Because of the low flux charge, the heats always melt with a good active slag and little if any slag conditioning is necessary. Neither do the heats foam, probably because of the amount of carbon in the slag.

To obtain the best results, the following practice is recommended: Charge the graphite directly on the furnace bottom. Mix and charge 0.25% Si and 0.25% Mn based on the total metallic charge. In the basic process, the manganese should be added as spiegel for better distribution. In the acid process, the silicon can be added in any form. Charge a layer of steel scrap. Charge 1% burnt lime, spreading well over the charge. Charge about 60% of the scrap, and melt down for about one hr. before finishing the charge.

The addition of manganese and silicon to the charge will protect the carbon and prevent its oxidizing too rapidly.

—John O. Griggs. *Blast Furnace & Steel Plant*, Vol. 32, Sept. 1944, pp. 1065-1067.

Mill for Brass Rolling

Condensed from "The Iron Age"

The Krause mill was developed by the Lewis Foundry Div. of the Blaw Knox Co. While initial installations are used for rolling copper and brass, tests of the mills indicate that they also are applicable to rolling steel.

Instead of the material passing through power driven rolls, it is held in tension by a gripper, and the rolls are moved by frictional contact between cam plates and the metal between the rolls, approximating "turks head" rolling. Cam plates and housing that hold rolls in position apply pressure on the work stroke in the direction of the finished end of the material.

The process is used for reducing 0.5-in. material up to 26 in. wide to 0.30-in. gage in a single pass. The same equipment can be used to roll gages as low as 0.005 to 0.010 in., as well as to reduce 1-in. thick slabs to 0.050 in. Hot reduction of slabs 4 to 5 in. may be accomplished with suitable equipment.

In the 28-in. mills erected for C. G. Hussey Co. and the Pittsburgh and Michigan divisions of Revere Copper & Brass Co., the rolls are 4 in. in diam. and 28 in. long, and are high carbon chromium steel forgings. Since no pressure is placed on roll necks, plain bronze bearings are used.

The housing for the rolls and cam plate,

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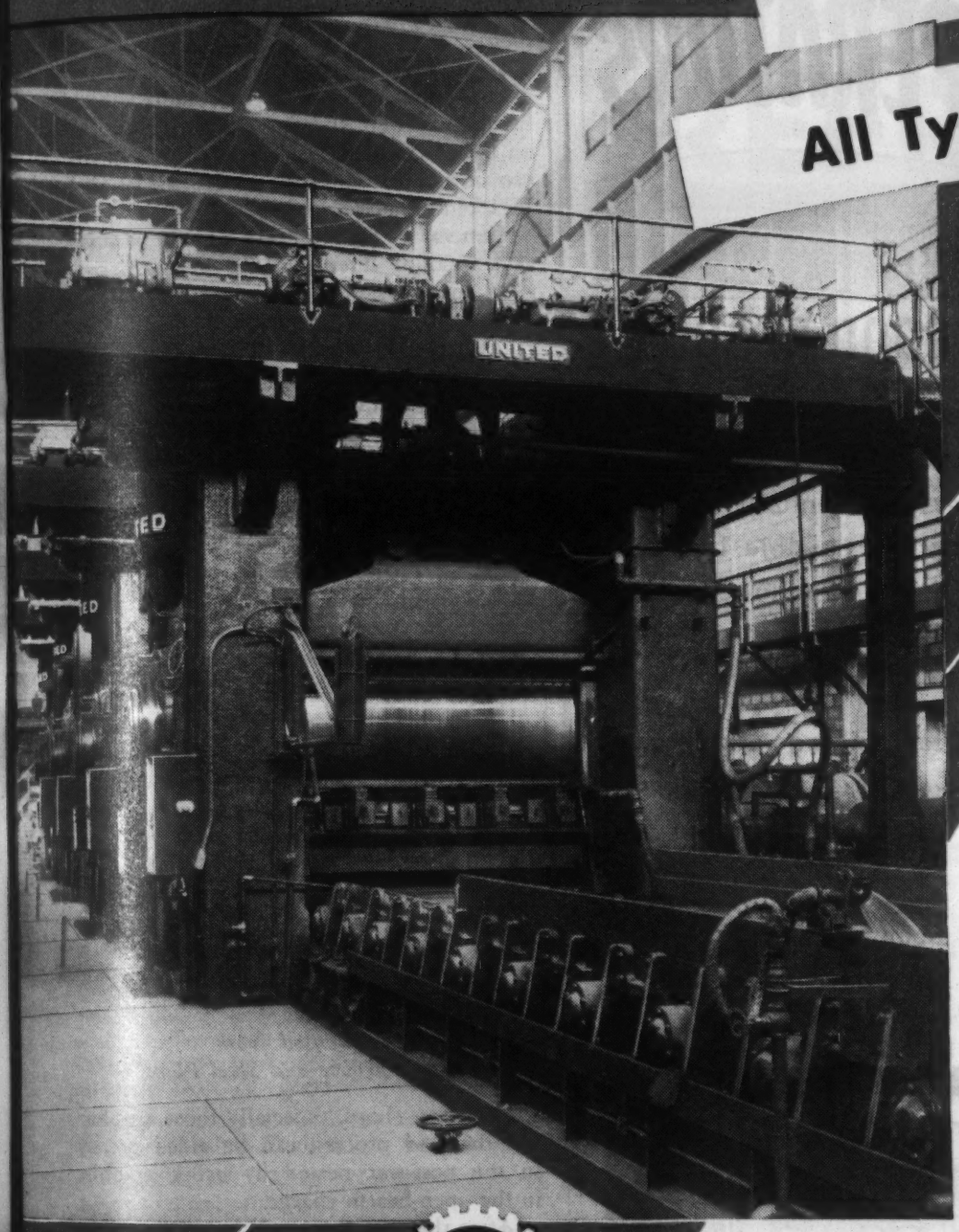

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And there is. The reason is very simple. Fitch Recuperators because of their scientific construction of the right materials have much longer life. Eventually, when they do need repairs, they are easily accessible. Injured tubes can be replaced in a few hours' time. Practically every steel company that has ever installed a Fitch Recuperator has later ordered additional ones.

With Fitch Recuperators there is less leakage and more heat transfer. Take less space—an asset where space is limited.

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Big steel companies use Fitch Recuperators in Strip, Structural, Wire, Slab, Billet, Rod, and Tube Mills.

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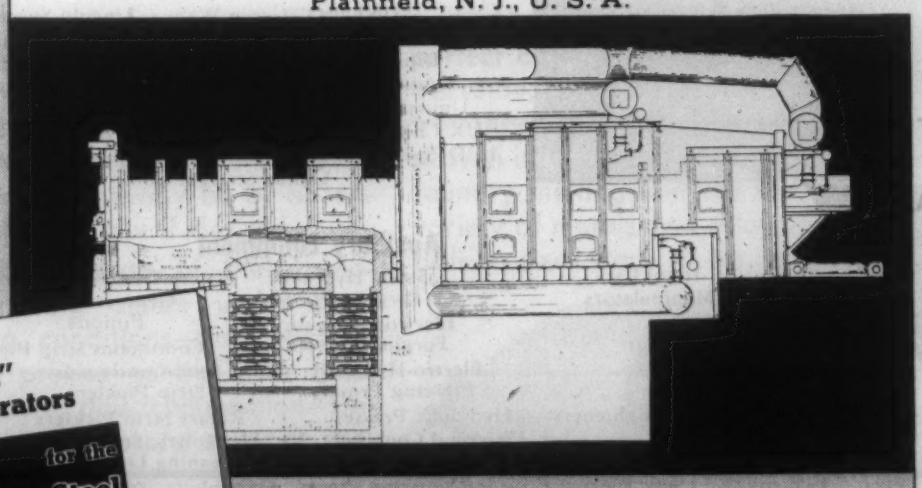

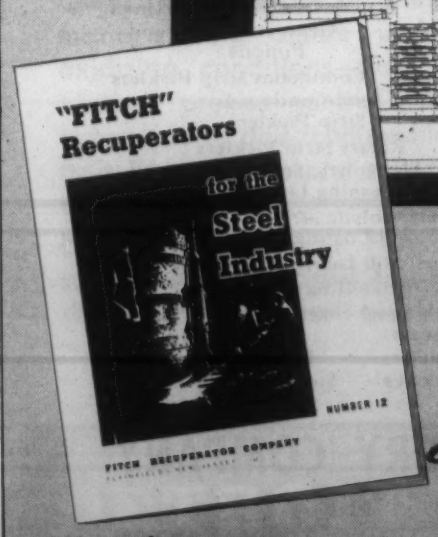

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recommendations of the manufacturer of the equipment relative to installation.

After installation, necessary spare parts should be stocked; a schedule for general overhauling at regular intervals should be set up and carefully followed; minor maintenance jobs, such as blowing out impulse lines, cleaning temperature elements and pyrometers, and replacing thermocouples, should also be scheduled; a complete record of each installation should be kept and carefully filed and indexed; and external inspection of all instruments and controls should be made daily by the maintenance men.

It is advisable to have chart changing done by one person, as the charts are in better condition, there is less wear and tear on the instruments, inventory of new charts can be smaller, and used charts can be filed in a central place.

General overhauling can usually be done at six-month intervals. On lines carrying dirty materials or water, cleaning must be done much more frequently.

The use of stainless steel nipples at the orifice has been recommended to eliminate build-up of iron oxide in the orifice taps and reservoirs on steam-meters. A Monel metal orifice is now being tried in place of a stainless steel one that had almost entirely corroded away after almost five years in a compressed-air line.

If the instrument manufacturer would use good substantial hardware, many maintenance troubles would be eliminated.

—W. J. McGregor. *Iron & Steel Engr.*, Vol. 21, Sept. 1944, pp. 54-55.

Graphite in Open Hearth Charge

Condensed from "Blast Furnace and Steel Plant"

Cold-iron shops, especially those employing the acid process, can be aided greatly in the post-war period by using graphite in the open-hearth charge.

After the war, there will be an enormous amount of scrap available, and the price will be much lower than at present. The use of all-scrap and graphite in a small cold-iron open-hearth furnace will show considerable savings over the conventional pig-iron-and-scrap charge in the same furnace. Where steel with more than 1% C is being cast, the use of graphite in the acid process can eliminate the necessity of charging special, high-priced, low-phosphorous iron.

Experience indicates that the elimination of pig-iron entirely is advantageous, as the oxidation loss is less by about 4% because of the absence of the impurities that are contained in pig-iron, and graphite heats can be handled easily during the working period. The yield is higher with the graphite charge.

While it can be assumed that, since the graphite charge has less than 50% of the impurities of a conventional type heat, cleaner metal should be produced, results

A FEW FACTS ABOUT CORHART PRODUCTS

Corhart Electrocast Refractories are high-duty products manufactured by melting selected and controlled refractory batches in electric furnaces, and casting the molten material into molds. After careful annealing, the finished shapes are ready for shipment. Dense, high-melting refractories, they are especially designed for resistance to corrosive action.

PRODUCTS

CORHART STANDARD ELECTROCAST is a high-aluminous refractory.

CORHART ZED ELECTROCAST is Zirconia-bearing.

CORHART ELECTROPLAST is a high-temperature plastic refractory made from Standard Electrocast which has been ground and crushed. Especially designed for ramming. Furnished dry.

CORHART MORTAR is a high-quality cement for laying up Electrocast, clay brick, or any aluminous refractory.

CHARACTERISTICS OF STANDARD ELECTROCAST

POROSITY: Less than 0.5%—therefore virtually no absorption.

FUSION POINT: Cone 38 without any appreciable softening below that point.

HARDNESS: 8, Mineralogist's scale.

SPECIFIC GRAVITY: Blocks weigh approximately 183 lbs. per cu. ft.

COEFFICIENT OF EXPANSION: 0.000006 between room temperature and 900° C.

SPECIFIC HEAT: 0.25 cal. per gm. per °C. at 980° C.

THERMAL CONDUCTIVITY: 25 BTU per sq. ft. per hour for gradient of 1°F. per inch.

COMPOSITION: Standard Electrocast is of an aluminous crystalline nature.

CORROSION: Because of low porosity and inherent chemical make-up, Corhart products are highly resistant to corrosive action.

APPLICATIONS

Most heat processes present spots where a better refractory material is needed in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the refractory "balance" desired.

The following is a partial list of applications for which Corhart Products are suggested:

ELECTROLYTIC CELLS — for production of Magnesium and other light metals.

SILICATE OF SODA FURNACES — sidewalls, bottoms, and breastwalls.

HEARTHS AND SMELTERS — for non-ferrous metals.

ALKALI AND BORAX MELTING FURNACES — fast-eroding portions.

GLASS FURNACES — the entire installation of flux walls and bottoms, breastwalls, ports, tuck-stones, forehearths, recuperators, etc.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES — flux walls and bottom.

BRASS FURNACES — metal contact lining.

ELECTRIC FURNACES — linings for rocking type, and rammed linings of Electroplast for this and other types.

BOILERS — clinker line.

STOCK SHAPES AND SPECIALS

Standard and Zed Electrocast are made in stock shapes and in many special shapes. The weight of individual pieces may run to 3500 pounds.

IF YOU NEED A BETTER REFRACTORY—

● Corhart Electrocast Refractories are high-duty products which have proved considerably more effective than conventional refractories in certain severe services. If your processes contain spots where a better refractory is needed to provide a balanced unit and to reduce frequent repairs, Corhart Electrocast Refractories may possibly be the answer. The brief outline at the left gives some of the basic facts about our products. Further information will be gladly sent you on request.

Corhart Refractories Company, *Incorporated,* Sixteenth and Lee Streets, Louisville 10, Kentucky.

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QUALITY ECONOMY ENDURANCE

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"ZrH_2 + heat → Zr + H_2"

Zirconium hydride (ZrH_2) and titanium hydride (TiH_2) are chemical compounds of metal with hydrogen. They are quite stable at room temperature, yet above 300°C gradually decompose into pure metal and nascent hydrogen. The reaction is endothermic and absorbs a certain amount of heat. It requires continuous heating to decompose either zirconium hydride or titanium hydride. The evolving hydrogen produces a protecting atmosphere around each individual particle of the liberated metal.

The above hydrides come in the form of very fine powder of less than 300 mesh. They are not hygroscopic and can be preserved and handled either when perfectly dry or under water. They are not readily attacked by most acids. The most convenient method of storing and handling these powders is in perfectly dry state since then they can be accurately weighed and mixed with other powders, when used in powder metallurgy for the production of sintered alloys. When used in pure state they provide a pure hydrogen atmosphere which protects them and sweeps away all traces of other gases present in the vessel.

These hydrides are metal powders made safe for handling.

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with its attendant reciprocating parts, weighs 10 tons. Two manually operated screwdowns are provided for setting to the desired gage to be rolled.

Wedges between cam plates and the plate on the mill housing provide for adjustments. Four wedges with indicators on the screws graduated at 0.001 in. permit deflection of the cam plate to give the effect of a crowned roll.

In production, the peak load is 150 to 175 hp. for material 16 in. wide, equivalent to about 10 hp. to each in. in width.

Gripper jams are pneumatically operated and are moved by a screw. When feeding, the screw is driven by a 7½ hp., 1160 r.p.m., a.c. motor. Speed is 15 and 30 in. per min.

Strip rolled by the Krause method has a fine and even grain structure, with very little edge cracking in copper.

Production in rolling 26-in. material at 60 ft. per min. from 1 in. thick to 0.30 in. is 3000 to 4000 lb. per hr.

—*Iron Age*, Vol. 154, Sept. 28, 1944, pp. 60-63.

Metallic Tiled Furnace Hearths

Condensed from "Iron and Steel"

It has been common practice to fit heat-resisting plates on brickwork hearths subject to unusually rough and heavy usage, but this has been hindered by the relatively high distortion of such plates when continually subjected to cold loads. Moreover, the distortion causes the protective scale to crack off so the plates scale unusually rapidly.

The Incandescent Heat Co., Ltd., have introduced a patented Nicrotectile hearth for heat treating, carburizing and annealing furnaces that eliminates all the above disadvantages. The complete hearth area is covered by a series of small heat resisting tiles (no analysis given), positively interlocked so they cannot be displaced by rough handling. The design is such that distortion is avoided.

The entire hearth can be built up in a few minutes or individual tiles may be replaced. Tiles on either side of the hearth protect the furnace guard. There are front locking plates to bolt to existing furnace sill plates. Either standard interchangeable elements may be obtained or special sizes if necessary.

The Nicrotectile hearth facilitates charging and discharging, and a quick recovery of the temperature after charging a cold load. Moreover, it has a very great resistance to abrasion, thus reducing maintenance charges as compared with ordinary brickwork hearths.

Although these tiles were designed for hearths, they may be used for many other purposes. They are especially suitable for waste gas dampers operating at temperatures up to 1100 C. (2000 F.), where their use in many cases eliminates the necessity for water cooling.

—*Iron & Steel*, Vol. 17, Sept. 1944, p. 607.

Taylor ZIRCON

for

ALUMINUM OPEN HEARTH FURNACE BOTTOMS

Section thru Taylor Zircon bricks enlarged to Twice Actual Size to emphasize the "weld-like" joint of Taylor Zircon #701 Cement.

Unretouched photograph

16,000,000 lbs. of aluminum foundry returns were melted on the Taylor Zircon hearth of which these bricks were a part. Specimen removed for examination — the original Taylor Zircon bottom and side wall is still in service.

Note the clean, tight, weld-like joint of Taylor Zircon No. 701 Cement and complete lack of metal or oxide penetration in either the Zircon Brick or the joint. This is characteristic and not an unusual example.

Properties of TAYLOR ZIRCON REFRACTORIES and other pertinent data are given in Bulletin No. 200. Write for your copy today.

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2 Foundry Practice

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High Duty Iron Castings

Condensed from "Engineering Inspection"

At one time cast iron was limited largely to such units as gas cookers, hardware, and artistic ornaments. A large potential market for cast iron was created by the development of the internal combustion engine, in which field the ordinary high phosphorus gray iron was unsuitable for many applications. Low phosphorus irons, made from refined pig iron or from a mix containing steel scrap, were developed. With the mass production of motor cars, machine tools, etc., there was a demand for cast iron of higher physical and mechanical properties.

Meehan discovered that by inoculating with calcium silicide an iron that would normally cast white, physical structure could be controlled for any given section. The metal readily responds to heat treatment to give either increased hardness or increased physical properties.

Until 1938, the only General Engineering Specification for Cast Iron [in Great Britain] was one published in 1928, calling for a maximum tensile strength of 12.0 tons per sq. in. An addendum was published in 1941 calling for strengths from half again as high to twice the earlier figure. These are not the optimum results possible, as tensile strengths of 35 tons per sq. in. can be obtained by quenching from 870 C. (1600 F.) into oil and tempering suitably.

Castings in a modern foundry are made to meet rigid specifications, and technical control compares favorably with that of any engineering establishment. Raw materials, such as pig iron, steel, coke and sand, are tested, all melting are supervised, the proper mix of sand selected, and each tap of metal tested.

The method of molding depends upon several factors, such as size and shape of the casting, quantity required, service that the casting must fulfill, process of iron in which the casting is to be made, and dimensional accuracy required. Heavy castings requiring large molding boxes are made on the foundry floor, using handling equipment. Light castings in small quantity will use a single wood pattern, but metal patterns and special molding equipment are made when quantities justify the cost. Metal patterns permit working to very close dimensional accuracy, not uncommonly to ±0.010 in.

The molding and gating technique for an iron of say 25 tons per sq. in. tensile is very different from that used for a phosphoric iron. This is due to four factors, the higher melting point of a low phosphorus, low carbon iron, the higher rate of solidification, lower fluidity, and higher shrinkage.

Results of this control are shown in the low rejections reported by most foundries. At the foundry reported by the author, with a yearly production of about 8,000,000 castings, totaling 10,000 tons, from approximately 50,000 different patterns, rejects for all causes from the user were 0.6%.

—E. Hunter. *Engineering Inspection*, Vol. 9, Summer 1944, pp. 23-29.

Sandslinger Molding Practice

Condensed from "Foundry Trade Journal"

All molding operations require ramming. There are several methods of obtaining the desired results in molds and cores—hand ramming, jolt ramming, squeeze ramming, blowing, and sandslinger. Sandslinger resembles the action of throwing a small handful of loam into the mold, as in loam molding. The force of the throw is very great, and ramming is obtained by the impact of the sand itself.

The mechanism consists of a rotating impeller having only one cup-shaped blade or vane throwing or delivering sand to the mold or core. The stream of bonded molding sand is fed into the path of the cup travelling at a very high speed, where it is caught up in quantities similar to a handful once in each revolution and expelled from the rammer head in a downward direction into the mold. The velocity of this small handful of sand is such that impact with the sand already in the box actually penetrates and packs on, and so builds up a mass of uniformly rammed sand.

This is probably the nearest thing to placing grains of sand in a mold individually, and should be easily equal to hand ramming when done properly. The sandslinger works best on sand that is on the dry side, and in any case, patching of molds should be eliminated by attention to pattern design and condition.

The upper limit of size is only reached when the span of the rammer head arms is insufficient to travel over the box. Even a lathe bed 33 ft. long could easily be rammed by moving the sand along the side of the flask. The smaller work could

Faster-Start to Finish

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Because the sailing of a ship, for example, might be held up because a contractor had to wait for a casting like the one in the illustration. With Truline, foundry men find jobs run smooth—and faster. First, you save time in making the cores themselves. Then you save in baking and clean-up.

But the real pay-off and probably as important a time-saver as any comes with final inspection. Rejects because of "off size cores" or "hot tears" are fewer when Truline cores are used.

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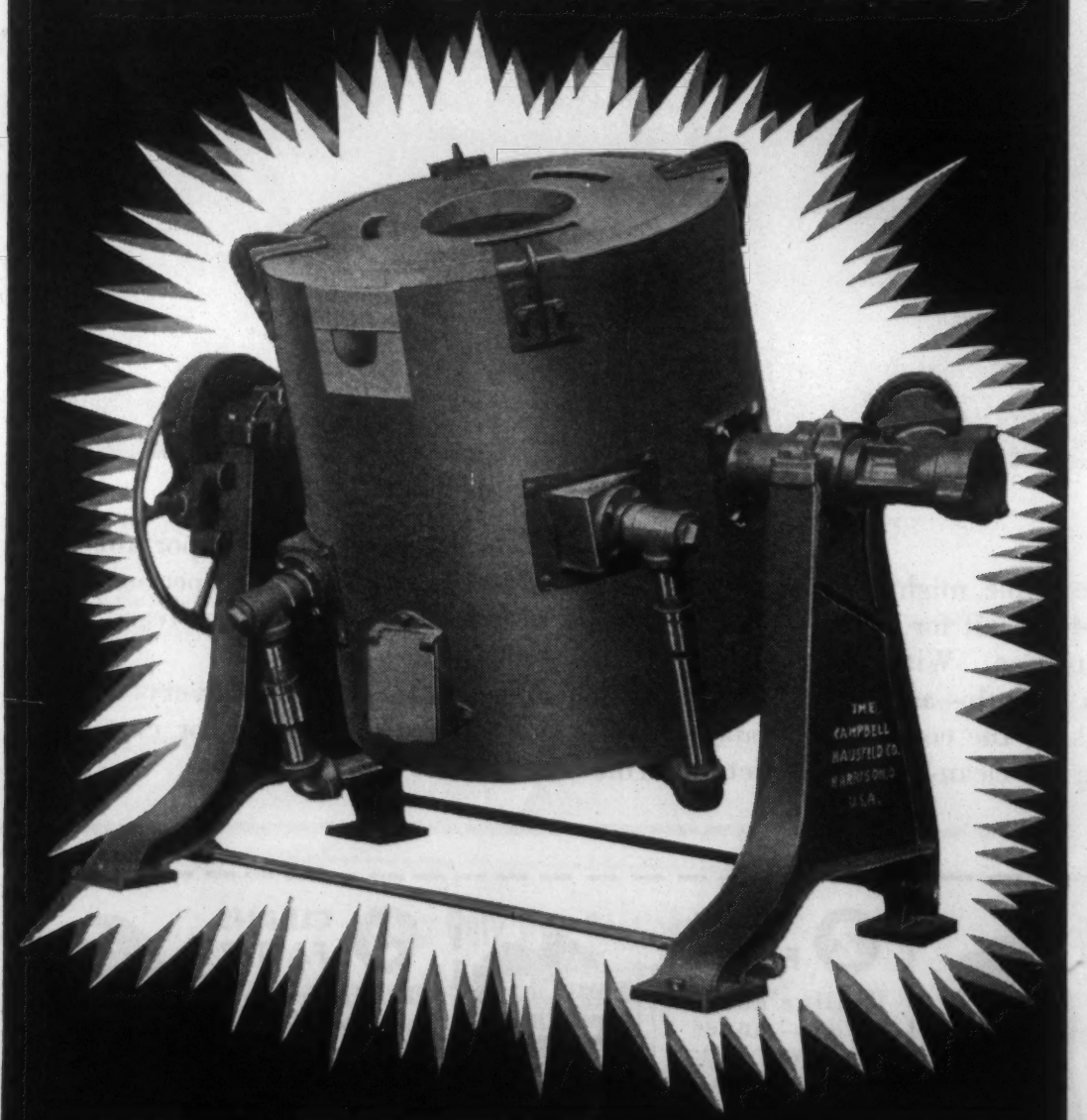

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IN THIS GREAT WORK
FURNACES FOR BRASS, ALUMINUM, MAGNESIUM AND ALL OTHER NON-FERROUS ALLOYS
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readily be made down to flasks 20 in. square where the spillage is not very bad. There is a great deal of work that is flat on one side and can be rammed without registration on a plate.

In preparing a plant for ramming with the sandslinger, a permanent cement odd-side was made on which the pattern was placed wide-side down, and after fixing the gate pins in holes in the odd side and setting vent pins, etc., the midpart was rammed up, then the drag rammed up. The flask was then secured and rolled over and the odd side removed, the parting finished, and the top rammed up.

The timing for each method was: 92½ hrs. for molding tray by hand, and 59 hrs., 50 min. for molding by slinger machine.

—W. Y. Buchanan. *Foundry Trade J.*, Vol. 73, July 27, 1944, pp. 249-253; Aug. 3, pp. 275-278.

Steel Foundry Synthetic Sands

Condensed from "Metal Treatment"

Molding sands for the steel foundry consist of silica (at least 80%), clay, and moisture. They may be classified as natural, synthetic, or semi-synthetic. Even before the war, the synthetic sands were finding increasing use as a result of the greater consistency and control of properties.

The compressive strength of sand at the actual temperature of test (as measured with A.F.A. test pieces) is of equal if not greater value than the usual standard tests. If the hot strength is too low, there is danger of scattering or sand erosion, with the possibility of steel penetrating into the mold, causing a very rough surface on the casting. If the hot strength is too high, there is an increased tendency for the formation of hot tears.

Natural sands have lower hot strengths than synthetic sands. Compo (crushed fire brick, old crucible pots, etc.) differs from all other sands in that the peak hot strength is not yet reached at 1000 C. Synthetic sands can be compounded to give any desired hot strength.

Semi-synthetic sands are intermediate in hot strength, and the safest to use for all-around purposes. Of the semi-synthetic sands, the floor or knockout sand has the highest hot strength, the pure semi-synthetic sand is intermediate, and the semi-oil sand is lowest (although the oil reduces the hot strength, the heat developed by its combustion tends to offset the beneficial effects of the low strength on the prevention of hot tears).

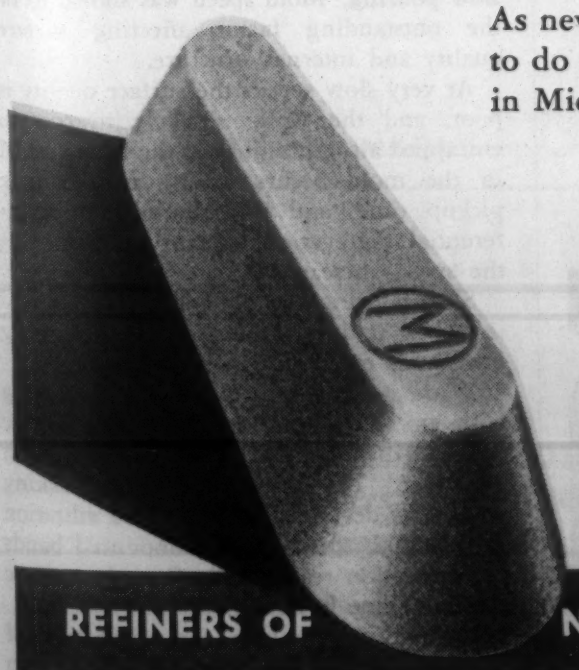
Green and dry strength and permeability tests of semi-synthetic sands showed that the best results were obtained with 4 to 5 min. milling time. Overmilling must be avoided to prevent tears and keep the hot strength to a minimum. Undermilling is preferred, as it markedly reduces the hot strength and hardly affects the dry strength. The green strength showed a peak at 5 min. milling time.

The best milling time for maximum permeability is 4 to 5 min. Therefore, a milling time of 2 to 3 min. is recommended with 4 to 5 min. maximum. An increase in ramming (A.F.A. test) increases strength and decreases permeability, but the properties become fairly well stabilized beyond certain limits.

The metallurgists and technicians in the plants of Michigan Smelting are constantly searching for ways and means to improve the quality of our ingot.

In our laboratories and smelting rooms are the latest, most modern laboratory and production controls—assuring that the ingot you receive, will meet your specifications.

As new methods—new equipment are developed—that will enable us to do even better than our present best—you will find their adoption in Michigan Smelting plants.



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Pure oil sands are necessary in many cases, but whenever trouble has been encountered with blow holes and hot spots, it has been usual to switch to pure clay bonded sands. However, intermediate semi-oil sands, where only a portion of the clay has been replaced by core compounds, are well worth trying. Tests on Levenseat silica sand with 4% Scottish fireclay and 1 to 7% Aske's semi-solid core compound showed that increasing amounts of core compound increased the compressive strength with satisfactory permeability and adequate green strength for most types of work, while the amount of moisture for optimum properties steadily decreased with increasing amounts of core compound.

When 1½ to 20% fireclay was added to the silica sand with 4% of the same core compound, increasing amounts of fireclay gradually increased the green strength and the amount of water needed for optimum values. The dry strengths were maintained, although higher moisture contents were needed, and the permeability was fairly high until there was a considerable proportion of clay, when it began to drop steadily. Generally, the extra cost of silica flour is not justified.

A wide variety of semi-oil sands are available, and their use is often advantageous, especially as the clay additions reduce the dry compressive strength and help prevent the formation of tears.

—H. E. Crivan. *Metal Treatment*, Vol. 11, Summer 1944, pp. 91-102.

How Centrifugal Casting Affects Structure

Condensed from "Journal of the Institute of Metals"

In order to determine the effects of mold speed, casting temperature, rate of pour, and mold temperature in horizontal centrifugal casting, tests were made with three alloys. An aluminum alloy bearing 6% Cu, a 6% tin bronze, and a 70-30 brass were used.

The centrifugal castings showed a considerable refinement in crystal structure over static castings made at the same time. Small crystal size was found to be improved in general by a low casting temperature and mold temperature, a high mold speed, and slow pouring. Mold speed was shown to be the outstanding factor affecting surface quality and internal structure.

At very slow speeds the surface quality is poor, and the work is likely to contain entrapped air. Splashing of the liquid metal in the mold occurs, owing to the long pickup time, and this results in circumferential segregation. Quality improves as the speed increases.

Slow pouring also tends to reduce splashing, but unduly prolonging the pouring time leads to a cold-lap in the work.

With suitable pouring conditions along with an increase in mold speed, structure becomes uniform and bands of segregation disappear. The machine used in making these tests developed considerable vibration at very high speeds, and pronounced bands of segregation reappeared. Crystal structure was quite fine however.

In order to confirm the association of segregated bands and vibration, rather than

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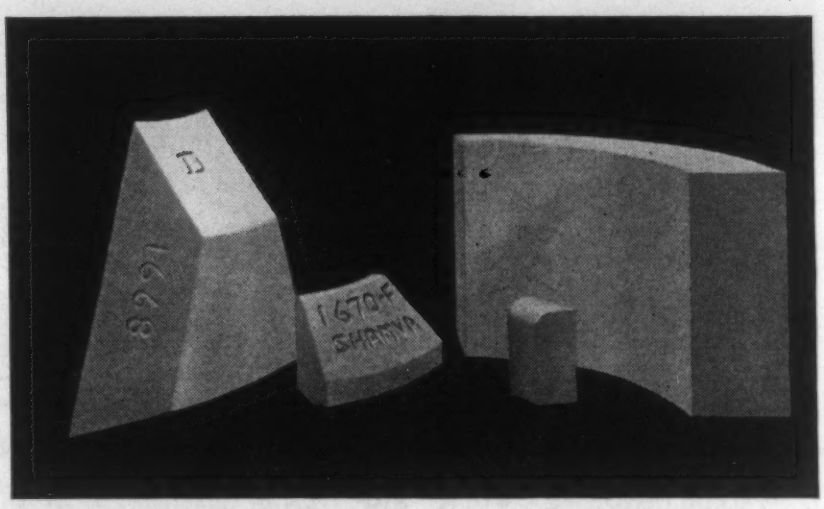

"Shamva" Mullite circular shapes give improved service life in furnace linings.

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2. Shop practice
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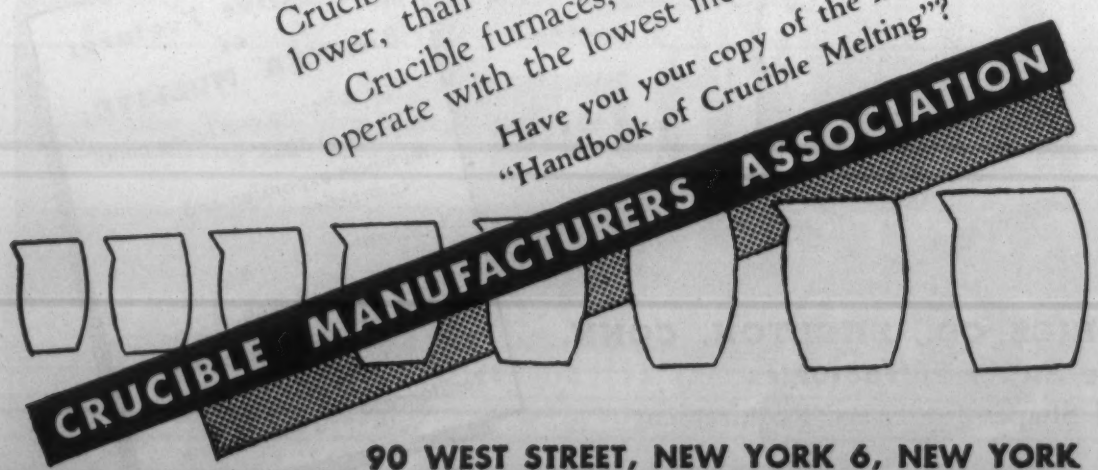


90 WEST STREET, NEW YORK 6, NEW YORK

with high speed alone, tests were made on vibrated unrotated ingots. The segregation was reproduced in this way, banding similar to that in the centrifugal castings being observed.

Samples for chemical analysis were taken from radial positions in the castings. It was shown that the 70-30 brass showed little variation in composition, but the aluminum alloy and the tin bronze, normally prone to inverse segregation, show this same feature in centrifugally made castings; however, the sharply defined edge of the segregated band is on the mold side in the centrifugal castings. This is thought to be due to centrifugal action giving rise to a difference in the direction of solidification.

Solidification in general proceeded from the outside toward the inside.

—L. Northcott & V. Dickin. *J. Inst. Metals*, Vol. 70, July 1944, pp. 301-323.

Compressed Air in the Foundry

Condensed from "The Foundry"

The efficient use of compressed air in the foundry is based upon the following considerations: (1) The compressed air plant; (2) proper size and arrangement of air piping and receiver layout; (3) the greatest utilization of compressed air devices so as to benefit from the most modern practice in the art; (4) the proper maintenance of the entire compressed air system including the piping, receivers, etc.; and (5) the proper maintenance of the various foundry devices that use compressed air.

The compressor plant must be housed to maintain it clean and free from dirt and grit. A regularly cleaned filter on the air intake is essential, and the manufacturer's instructions regarding lubrication, cooling, and general maintenance should be carefully followed. An aftercooler should be installed in the compressed air plant to minimize moisture in the compressed air supplied.

Particular care should be taken to insure proper, but not excessive, lubrication of compressor cylinders, as excessive quantities of oil in the discharge line or the receiver constitute a fire hazard. Placing the aftercooler between the compressor and the receiver, as near as possible to the compressor discharge, should result in more uniform and satisfactory operation.

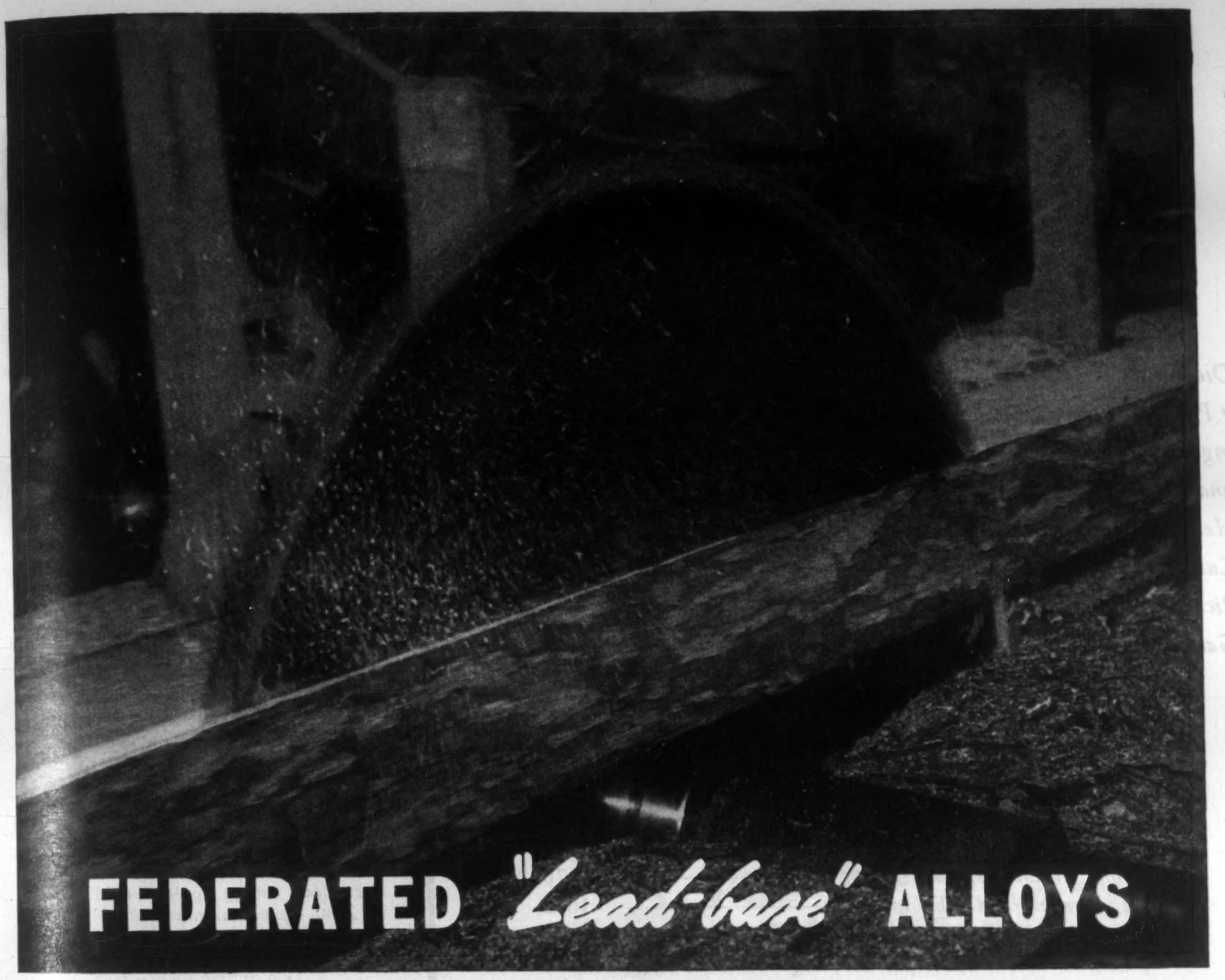
The compressed air piping should be designed with due consideration for the air-demand of the normal working pressures of the compressed air devices.

Pressure drop due to friction in piping may be computed from a chart presented in the article. Equipment using large quantities of compressed air, such as sand blast machines, should be as close as possible to the compressor plant to avoid long air lines.

Piping joints should be tested periodically for leaks, with the foundry shut down and no pneumatic tools operating while the compressor is running. This will indicate the capacity at which the machine must be operated to maintain the air pressure at the normal point. Hose connections should also be checked frequently for leakage.

Regular inspection of pneumatic tools with special regard to lubrication is recommended.

—J. L. Yates. *Foundry*, Vol. 72, Oct. 1944, pp. 80-81, 238.



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Crush Forming for Ground Contours

Condensed from "American Machinist"

Crush forming is the process of shaping abrasive wheels so that the contour produced can be transferred to the workpiece during a grinding operation. It is done with rollers of high-speed steel, 18 W, 4 Cr and 1% V, and is often called roller dressing or roller forming.

The process has been used successfully in Europe for several years. It speeds machining of many kinds of contours on work such as circular and flat forming tools, die segments, broaches and other irregular profile tools and gages and production parts.

Three machine tools complement one another to provide full utilization of wheel crushing and plunge form and thread grinding techniques: (1) The microscope form grinder for manufacturing and inspecting flat or cylindrical original masters and general profile tools; (2) the plunge full form and thread grinder for fast high production parts, such as threads and intricate forms; and (3) a good surface grinder for rapid high production of flat tools and production parts using the crusher roller method of wheel dressing.

Six advantages of wheel crushing and full-form grinding are: (1) On intricate profiles, full form crushing fashions the entire wheel to the desired shape in a fraction of time needed by conventional dressing methods; (2) a better cutting surface results, with more free-cutting points on the grinding wheel; (3) it increases the number of pieces ground per dressing, not needing redressing after every wheel pass, and the wheel bond retains its strength and adhesiveness; (4) cost of dressing tools is slightly reduced from quantity ground per wheel dressing and large number of crushings or dressings per life of crusher; (5) grinding time is reduced two-thirds; and (6) it makes unusual uniformity of threads, lead and pitch diameter, eliminating thick first and last threads.

In operation for flat work, initially the operator lowers the stationary grinding wheel into contact with the stationary crusher. While retaining downward pressure with the lowering wheel, he starts the roller motor and easily feeds the wheel into full form depth. Slightly more than one complete revolution of the grinding wheel, after penetrating to the full depth, ends the crushing. He then traverses table to the work grinding position, shutting off the crusher motor and starting the grinding spindle.

Pressure required for wheel crushing is remarkably light. Thus, the effective hardness of a grinding wheel is due to its rotating speed. Speed of rotation should be 300 surface ft. per min. Either aluminum oxide or silicon carbide grinding wheels can be roll crushed. A medium grade is best with grits from 150 to 220.

For form cutting, speeds should be 1725 to 2500 r.p.m., assuming wheel diameter of 12 in. The workpiece should rotate from 150 to 200 r.p.m.

—John Haydock. *Am. Machinist*, Vol. 88, Sept. 14, 1944, pp. 98-101.

Forming Light Metals

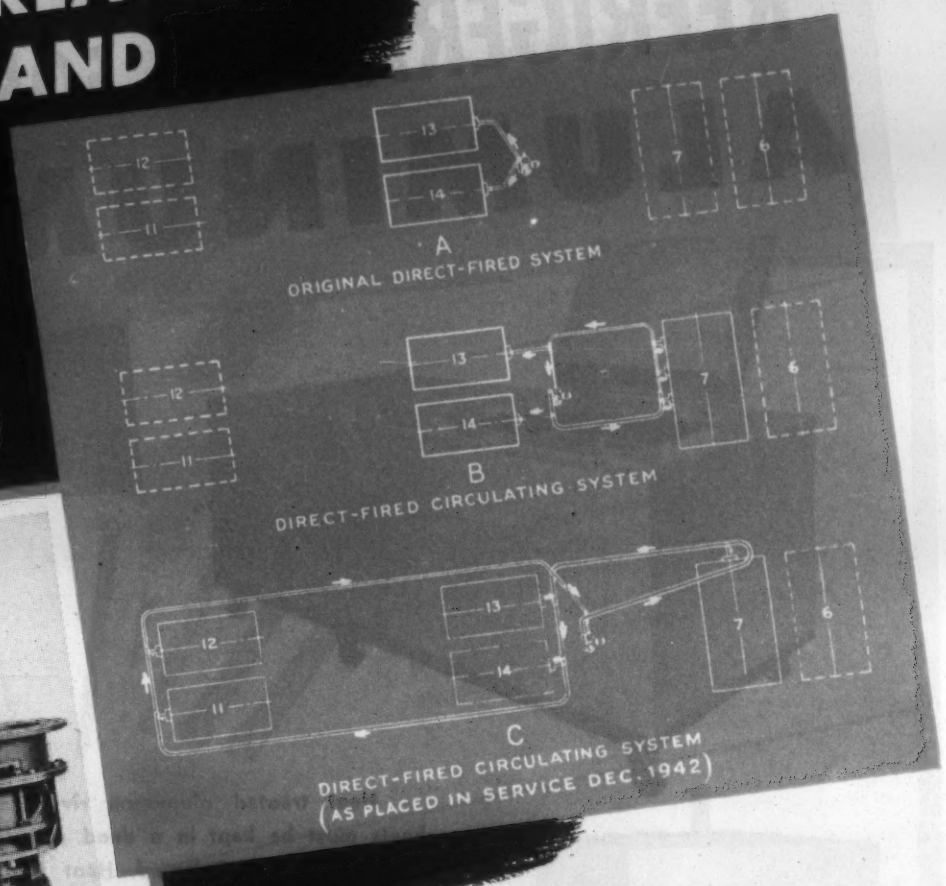
Condensed from "Mill and Factory"

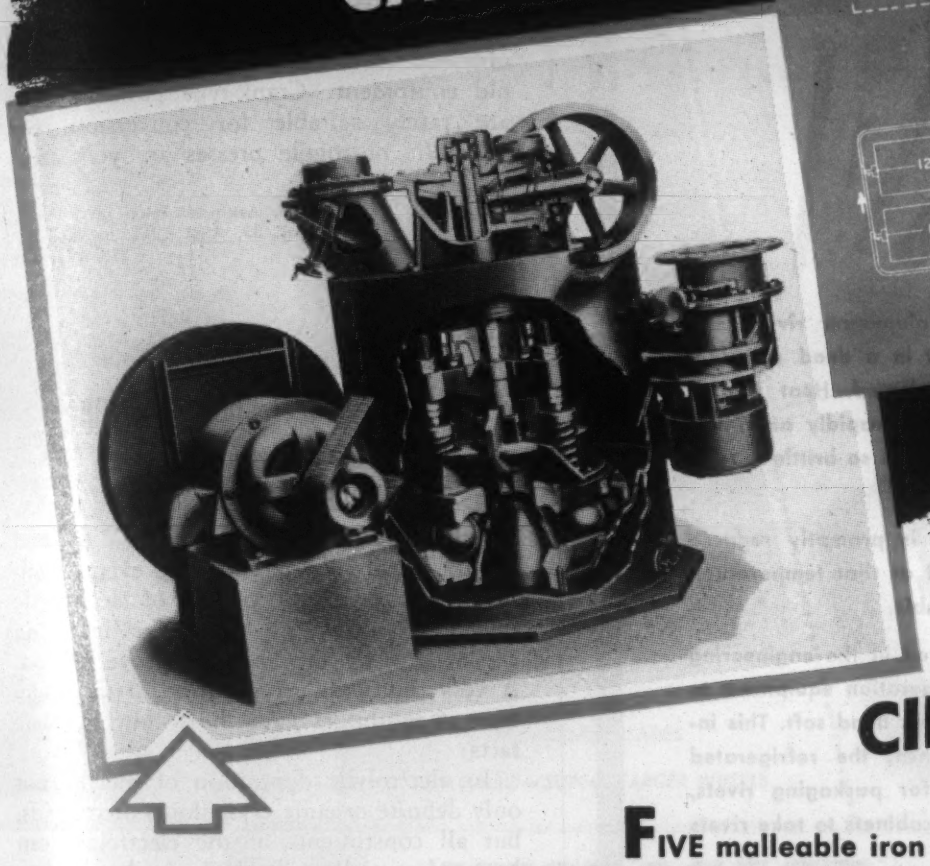
The Guerin process, using rubber pads, which was developed during the war, offers an inexpensive and simple method of forming parts even to small manufacturers. The Guerin process is the only recognized, all inclusive method of sheet forming if versatility of size and shape, speed of operation, quickness of design change and production are prime factors.

A hard die of metal, such as cast zinc alloy, plastic, or impregnated wood fibers such as Masonite, is used with a rubber pad under pressure. The rubber pad is entirely encased in a steel container except for the bottom or contact surface, which operates as a mating die when under pressure. In operation, the rubber flows around any obstruction and exerts a nearly equal pressure over its entire surface.

If hundreds of thousands of duplicates must be made, only steel dies are satisfactory. However, no process can match the Guerin if (1) the number of duplicates is to be under 50,000; (2) overnight design changes may be necessary; (3) it is desirable to keep the die cost at about $100

PRODUCTION INCREASED, HEATING CYCLE AND FUEL COST CUT, IN ANNEALING MALLEABLE CASTINGS





The B&W Type B Pulverizer, widely used in pulverized-coal systems for firing boilers, cement kilns, and metallurgical furnaces—where sustained capacity and fineness of product, and continuous low-cost operation, are desirable.

WITH DIRECT-FIRING PULVERIZED-COAL CIRCULATING SYSTEM

FIVE malleable iron annealing kilns converted from hand-fired coal to the B&W Direct-Firing Pulverized-Coal Circulating System by the steps indicated above now operate with a reduction in fuel cost of 23 per cent, a greatly reduced heating cycle time, and increased production.

The results being obtained with this application of the B&W Direct-Firing Pulverized-Coal System can readily be duplicated. With this system, the pulverizer can be set where convenient and the fuel-circulating piping led to one or more furnaces, with multiple take-offs to burners at individual furnaces. Kiln temperature is controlled by similar methods as with oil and gas firing, and with the same ease of operation. Fuel distribution and capacity of the system, whether for single or multiple furnace operations, is assured by automatic control of coal-to-air ratio, by selection of the proper sizes of pulverizer, distributing fan, burners, and distributing line—details that are readily determined from the wide experience of B&W with pulverized-coal firing.

The merits and economy of pulverized-coal firing for metallurgical furnaces are discussed in B&W Bulletin 3-333, a copy of which will be sent on request.

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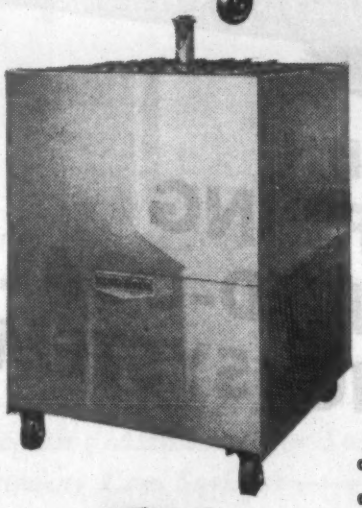
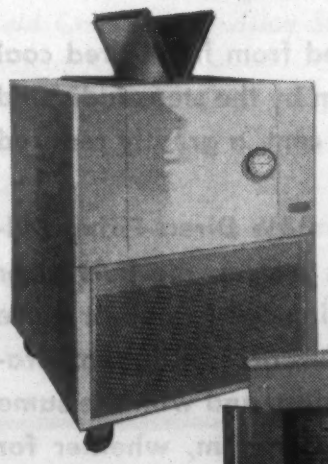
REFRIGERATION FOR ALUMINUM



Heat treated aluminum rivets and sheets must be kept in a dead soft condition until used or fabricated. Heat treated aluminum age hardens very rapidly at atmospheric temperatures—becomes so brittle it can't be fabricated.

But if its temperature is promptly reduced to minus 40° F. and held at that temperature, the metal remains workable.

Kold-Hold has specialized in the engineering and manufacture of refrigeration equipment to keep heat treated aluminum dead soft. This includes the refrigerated quench, the refrigerated alcohol bath, the canisters for packaging rivets, storage cabinets and mobile cabinets to take rivets to the assembly line.



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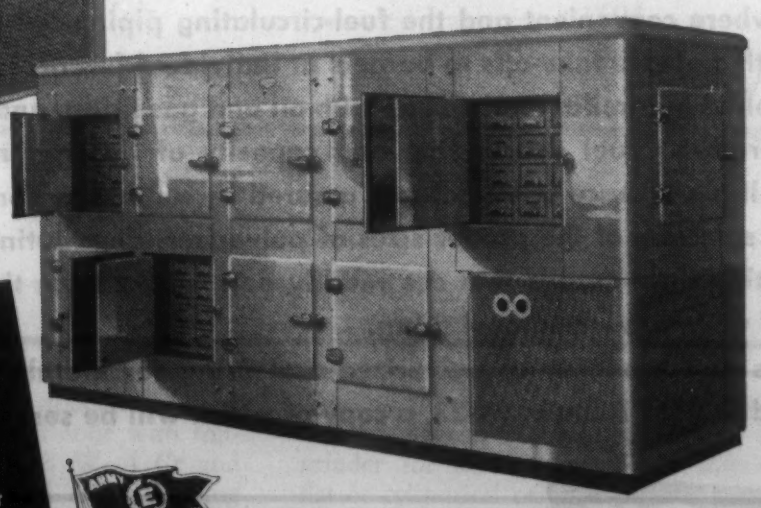

If you are working with aluminum, *Write* to KOLD-HOLD for CATALOG S-Z 431

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instead of $8,000 to $10,000; (4) the die should be in operation within 24 hr. rather than the 2 to 3 months necessary for finishing mating steel dies.

In the case of a deep-drawn wing rib, Douglas found the price of a pair of mating steel dies would be $8,000 to $12,000, whereas the total cost for a Guerin die (including die, labor and materials) was under $100. There is an additional saving, since the die is merely placed on the table in the Guerin process; it must not be bolted down.

There is a total lack of scratches in metal formed by the Guerin process. Furthermore, there is an additional saving since the sheet must not be lubricated before forming and, therefore, no oil must be cleaned off before further processing.

Special hydraulic equipment designed especially for the Guerin process may be obtained, but it is also possible to convert old equipment. Crank-type punch presses are rarely suitable for conversion, but hydraulic or toggle presses are very satisfactory.

—G. S. Ashmead. *Mill & Factory*, Vol. 35, Aug. 1944, pp. 105-107, 270, 274, 276.

Inhibitors in Electroplating

Condensed from "Zeitschrift für Elektrochemie"

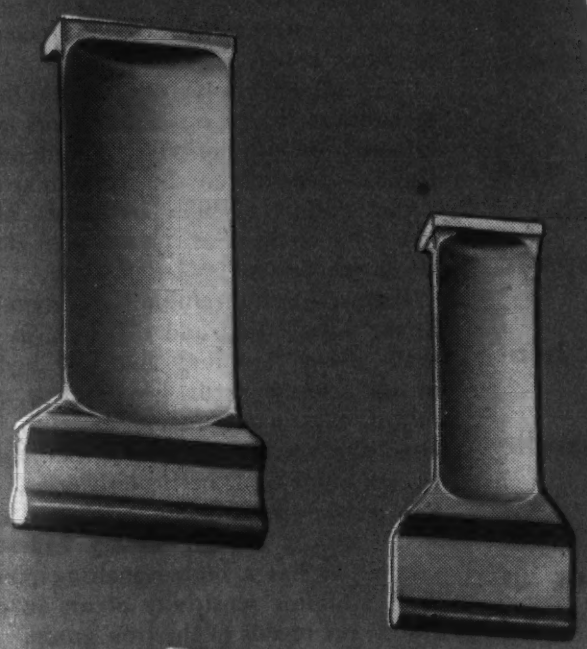
Inhibitors in general are colloids and certain organic crystalloids that exert a definite influence on the process of electrolytic metal deposition, in particular retarding crystal growth and increasing overtension. A very thorough investigation of the function of inhibitors gave the following basic facts:

In electrolytic deposition of metals, not only definite organic crystalloids or colloids, but all constituents of the electrolyte can be preferentially adsorbed to the surface of the cathode and thus cause overtension and retard crystal growth. The effect of these inhibitory substances is never due to one type of inhibitor alone, but is always the result of the joint action of all constituents of the electrolyte functioning as inhibitors. The cathodic deposition seems always to go on under the joint action of inhibitors.

The relation between metal overtension and number or size of the active places in the cathode surface can be employed in the same manner also to the blocking of the surface by inhibitors. Conceptions are developed showing the selective distribution of the various inhibitors in the adsorption to the different areas of the metal surface in the currentless state and in cathodically polarized condition.

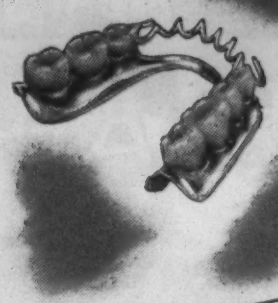
The inhibitor effect must take account not only of the reactions with the metal surface, but also with the electrolyte boundary surface. Surface inactive inhibitors are adsorbed, if at all, only at the metal surface; active inhibitors can be adsorbed together with their hydrophile group also to the liquid boundary surface. Simultaneous adsorptive binding to metal and liquid surface seems to reduce the cathodic efficacy of the inhibitors.

MICROCAST PRECISION CASTINGS PROCESS

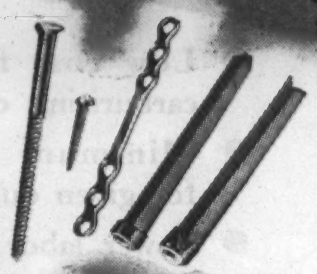


MICROCAST BLADES
FOR TURBO—SUPERCHARGER WHEELS

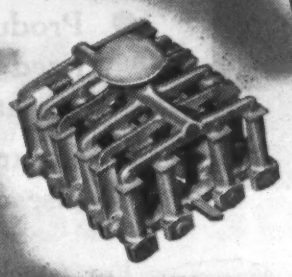
EVOLUTION OF THE MICROCAST PROCESS



Dentistry....
The MICROCAST PROCESS was developed in conjunction with the introduction of the alloy, Vitallium,* to the Dental Profession. The casting of this alloy required the development of an entirely new and revolutionary precision casting technique.



Surgery....
Surgical plates, nails, screws and special appliances have been made by the MICROCAST PROCESS since 1937. These Vitallium* surgical appliances are widely used in the field of orthopedic surgery for the internal fixation of fractures and in other surgical applications.



Industry....
For three years, the MICROCAST PROCESS has been utilized in the quantity production of castings which have fine dimensional precision as cast and require little or no machining. Smooth surfaces and dimensional accuracy of the cast parts approach those of machined parts.

*Vitallium, a non-machinable alloy

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MICROCAST is a term applied to the mass production of smooth, sound castings of unprecedented dimensional precision made by the AUSTENAL MICROCAST PROCESS.

The MICROCAST PROCESS is an application commercially of the investment technique of casting, originally developed and perfected by Austenal for the precision casting of intricate dental and surgical appliances. In quantity production, scores of millions of blades have been cast to precise tolerances for the turbo-supercharger wheels on U. S. Bombers and Fighters.

Many other castings of diversified shape, detail and design have been made of various metals and alloys by the process. The smooth surfaces and dimensional accuracy of these castings approach those of machined parts.

While this new process does not displace or limit conventional forging or machine shop methods, it represents an advancement in casting procedure, due to the precision and smoothness of the castings, regardless of their complicated shape. Hollow (cored) castings, and parts with internal and external threads are being successfully MICROCAST.

Industrially, MICROCASTING of parts to close tolerances offers in many instances definite economies in the casting of some of the high-melting point alloys which are very difficult to forge and machine on a commercial basis.

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MICROCAST

The precision process originated by Austenal Laboratories, Inc. sixteen years ago for the production of castings of intricate design where accurate dimensions and surface smoothness are absolutely essential. Many castings produced by the MICROCAST PROCESS require little or no machining.

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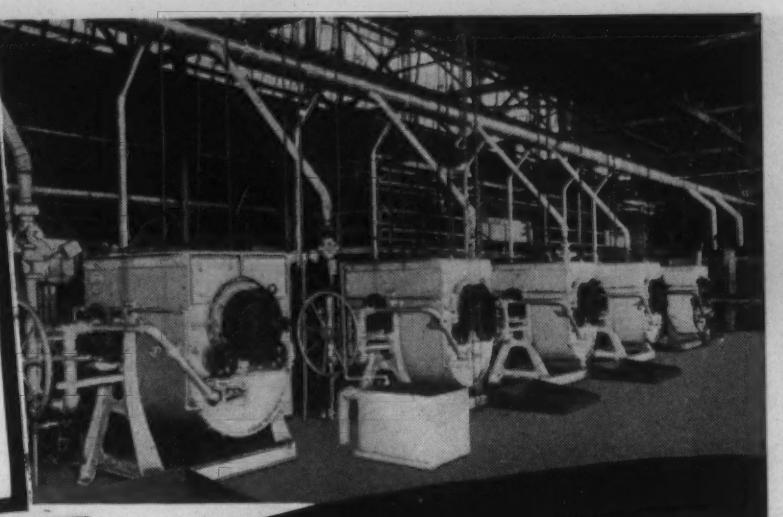
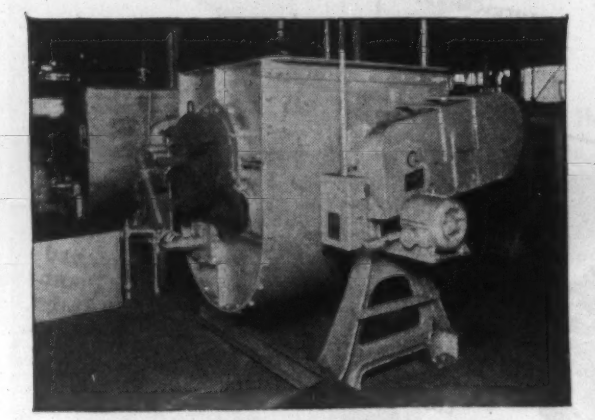
Produce More Uniform Case in Less Time at Lower Cost

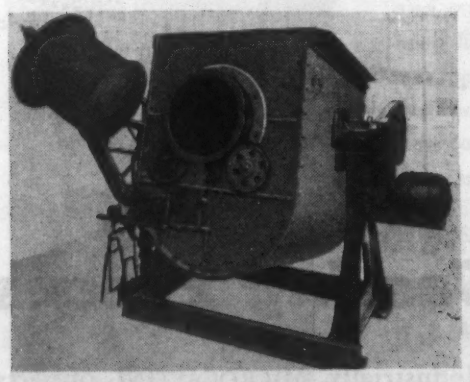


ROCKWELL *Rotary* **CARBURIZING FURNACES**

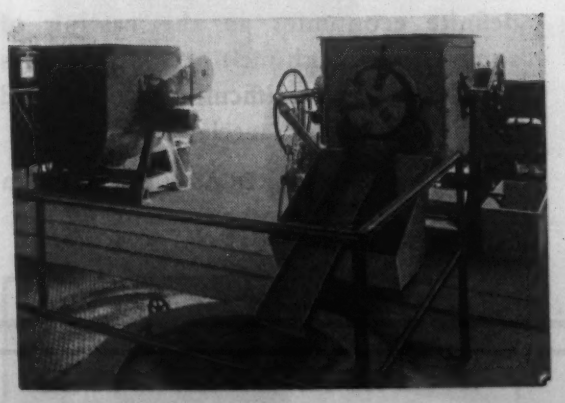
Battery of rotary carburizing furnaces in large automotive plant



Furnace in operating position



Furnace tilted for charging



Furnace with screen and discharge chute to quench tank

- Low cost for fuel and carburizing compound.
- Minimum floor space for given output.
- Lower labor cost for handling.
- No boxes to pack, handle and heat.
- Product may be carburized in compound or in gas atmosphere.
- Controlled uniformity of case depth.

For stock such as pins, cams, washers, rockers, rollers, balls, bolts, rings, etc., that may be slowly tumbled within safe limits for grinding, the Rockwell Rotary Carburizing Furnace is available in standard sizes to handle up to 700 lbs. per charge. An alloy retort revolves within a refractory casing supported on trunnions and is arranged to tilt backwards for charging and forward for discharging. Heating may be by gas, oil or electricity. The temperature of the charge is automatically controlled from both inside the retort and in the combustion chamber. The furnace is also well adapted for hardening, drawing, normalizing, annealing and other heat processing where tumbling the charge at 1 to 3 R.P.M. is not injurious.

Write for Bulletin No. 412

W. S. ROCKWELL COMPANY

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ROCKWELL SINCE 1888 BUILT

FURNACES · QUENCHING EQUIPMENT · OVENS · DRYERS · BURNERS · VALVES

In the surface-active phenol derivates, the tendency of the hydrophile group for binding to the metal surface is in some metals obviously stronger than the affinity to the water boundary surface. If a second inhibitor is added, the cathodic effect of the inhibitors does not simply add but a much stronger effect can be observed in which strongly adsorptive anions participate.

The inhibitory effect is not only characterized by the magnitude of the polarization, but can also be determining for the shape of the current density-voltage curve. As a rule, negative inhibitors act mainly on the lower part of the curve by shifting the potential to more negative values, while the upper part is only shifted parallel to the curve current density-voltage taken with inhibitor absent.

The different heavy metals are differently sensitive to the action of inhibitors in their cathodic deposition. The "inhibitor sensitivity" depends on the inclination of the surface atoms to bind inhibitors, as well as on the mobility of the atoms of the metals at the deposition temperature.

Particularly low inhibitor sensitivity shows in the metals lead and thallium, in which high atomic mobility and low hydration of the cations occur together. It is also low in the metals tin and bismuth, which also have low melting points, but is greater in cadmium and particularly zinc, which as cations are stronger hydrated, and in silver which, though weakly hydrated as cation, yet has a higher melting point. A high inhibitor sensitivity occurs in copper and in the metals of the iron group.

—H. Fischer. *Z. Elektrochemie*, Vol. 49, June 1943, pp. 335-358; July 1943, pp. 376-382.

Rolling Flanges on Hot Tubing

Condensed from "Aviation"

Using a flange rolling machine developed at Curtiss-Wright, time for forming and cutting off tubing is reduced to about two min. The metal is worked continuously during heating and forming, producing uniform results.

The capacity of the machine in forming tubing ranges from 1-in. diam. by 0.035-in. wall to 3½-in. diam. by 0.250-in. wall and tubing can be flanged on both ends. By the use of special jaws, tubing of 6-in. diam. and 0.250-in. wall can be flanged on one end only. Uses can be extended to the manufacture of double integral and central flanges, also external and internal upsetting.

The method consists in heating metal until it has attained a plastic state, following this by a series of press operations. During the process, the metal is rotated so that it is worked uniformly and is supported by backing rolls, which control flange formation. Forming rolls complete the steps so that the metal may be made any desired shape.

The machine is mounted on an 8-ft. I-beam, with web horizontal. At one end of the web is a cast iron head carrying a spindle in two roller bearings. The tubing has an inside diam. of 6½ in., and a housing projects from one end to receive a chuck and at the other, a work centering

THIS EASY-FLO BRAZED INSECTICIDE DISPENSER SOLVED A LIQUEFIED GAS CONTAINER PROBLEM

A ring of EASY-FLO wire is preplaced in a groove in one stamping before assembling the two parts and heating.

A development that has been a great boon to our armed forces is the "aerosol" method of combating malarial mosquitoes and other insect pests. It is based on the use of a liquefied gas as a solvent and propellant one of which is Freon, the well known refrigerant.

One of the problems was a container for the liquefied gas that would satisfy the requirements of field use. The answer was the container illustrated—made from cold-rolled steel stampings brazed with EASY-FLO.

That EASY-FLO was used, is not surprising. For it was well known, through wide-scale experience with EASY-FLO in the manufacture and installation of domestic, industrial and commercial refrigerating equipment, that this low-temperature silver brazing alloy reliably made high-strength, liquid and gas-tight joints—and did it fast and economically.

Unquestionably this thoroughly proved EASY-FLO brazed container points the way to the solution of numerous peace-time container problems. It adds more convincing evidence that when you need liquid or gas-tight joints that have to take it—braze with EASY-FLO!

GET EASY-FLO DETAILS

BULLETIN 12-A gives all the reasons for the outstanding speed, reliability and economy of low-temperature EASY-FLO brazing. It is "must" reading for all engineer-designers and men responsible for production. Write for your copy today.

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For instance:

Lower viscosity does not necessarily mean more effectiveness at the work area.

Dark oils are often cleaner than light-colored, clear-looking oils.

More total sulphur does not always mean better cutting quality.

Straight oils are often better refrigerants at the point of contact than soluble products.

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The wise buyer measures cutting fluids by how they perform on the machine. To find the best performing oil for his needs, he looks to experience.

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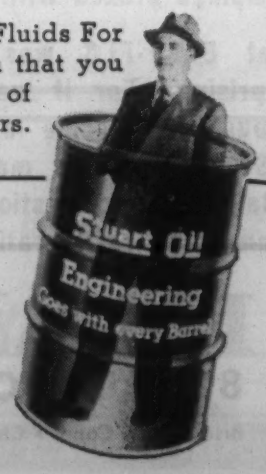
of the *New* Stuart 60 page handbook: "Cutting Fluids For Better Machining." It is full of data—information that you will find a helpful guide to the most efficient use of cutting fluids. It is free to executives and engineers.



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mechanism. The forming rolls are actuated by hydraulic pressure supplied by a pump under the bed of the machine.

Backup and flange limiting rolls are carried on an arm that pivots on the back of the bed. Rolls are operated by a lever. A heating unit and shut-off valve are operated by the same movement. Forming rolls are carried on the bed, which moves in gibs, and are powered by another hydraulic cylinder.

Rolls to produce a given flange are brought into contact with the plastic material with sufficient force to produce the finished part while the material is still hot. Carbide-tipped cut off tools are used. The tube is centered and clamped in the chuck with enough stock projecting from the face for forming. It is then heated above 1400 F. and kept uniform by rotating the tube.

The back-up roll is brought into position back of the tube end. This roll has an axis perpendicular to the tube. An expanding roll is then pressed into the tube. As the space between back-up and conical rolls will vary with changes in wall thickness, adjustments are made.

While the tube mouth is being flared, a turning roll is brought up against the flare perpendicular to the tube axis. Increase in diameter is prevented by a limiting roll.

Final stages involve the substitution of a flat finishing roll for the turning roll. Flange thickness is determined by travel of the flat roll and by radial metal flow.

—*Aviation*, Vol. 43, Sept. 1944, pp. 146-147, 249.

Choosing Metal Cleaners

Condensed from "Industrial Finishing"

The types of dirt common to most manufacturing operations may be classified as: (1) Mineral oils; (2) animal or vegetable oils; (3) combinations of animal or vegetable oils; and (4) insoluble matter, either alone or in combination with one or more of the above oils. Any one of these alone, or a combination of them, will require a cleaner adapted to the type of soil involved.

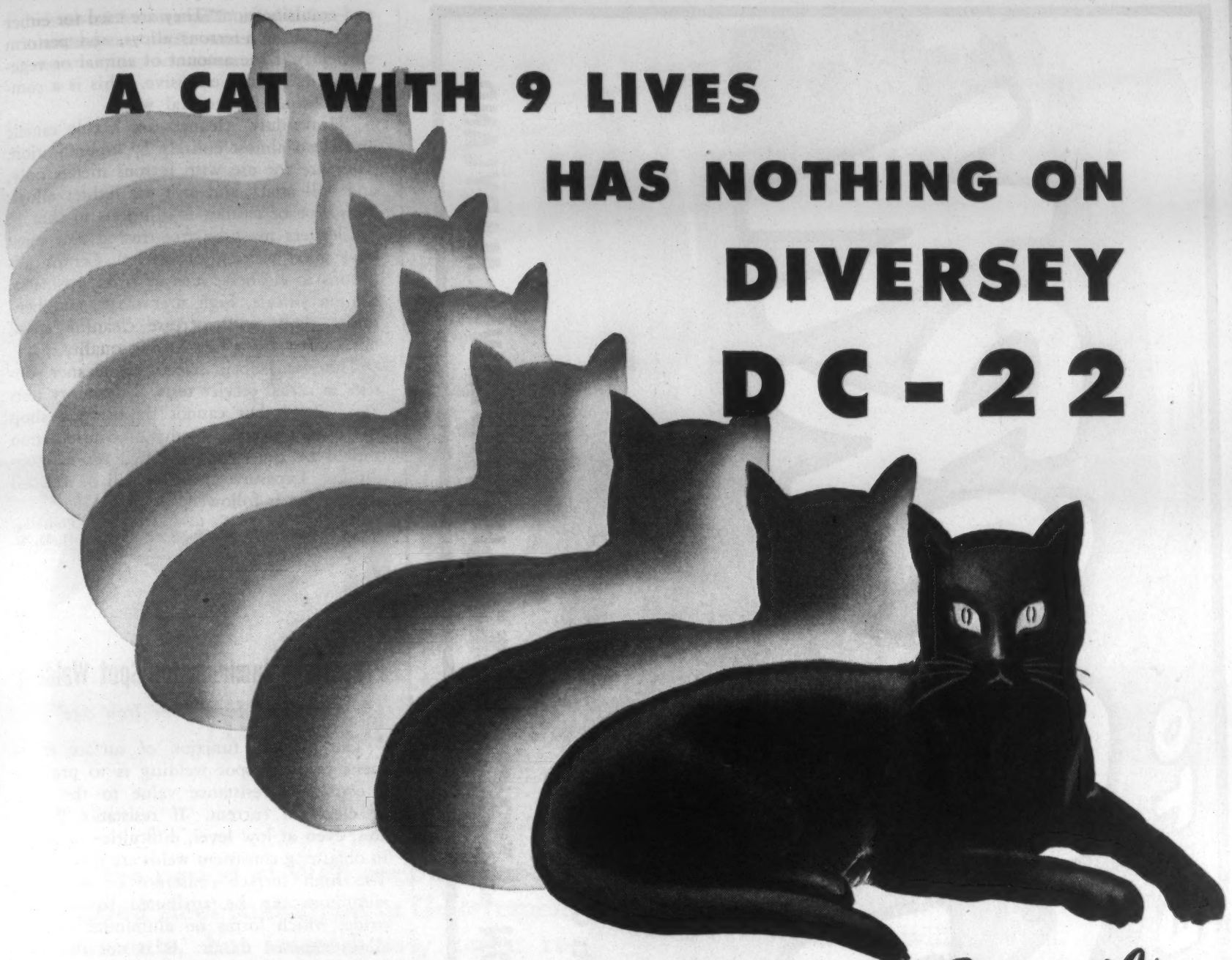
Mineral oils, which are probably the most common type of soil, are removed by emulsification. This is a physical action, in which the oil becomes dispersed as fine particles in the cleaner. Animal or vegetable oils are removed by saponification. This is a chemical reaction in which the oils are converted into water soluble soaps.

If both types of oil are present, the cleaner must both emulsify and saponify, but should be compounded with regard to the proportions of each type of oil in the soil. A predominantly emulsifying cleaner will be inefficient if the soil is largely an animal or vegetable oil.

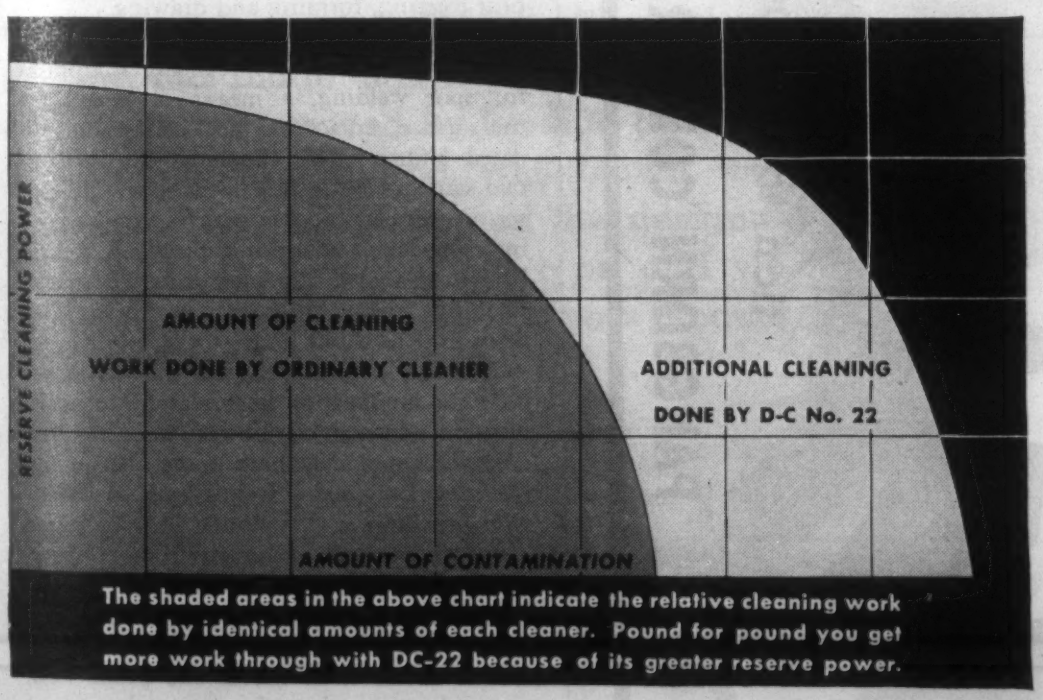
"Light-duty" cleaners clean almost entirely by emulsification. They are not caustic, and are employed principally for cleaning light alloys, especially aluminum, and for steel when the amount of soil is slight and is of neither vegetable nor animal oil composition.

"Medium-duty" cleaners are of medium causticity and clean both by saponification

A CAT WITH 9 LIVES HAS NOTHING ON DIVERSEY D C - 2 2



THIS HEAVY DUTY CLEANER FOR IRON AND STEEL HAS *Reserve Power*



The shaded areas in the above chart indicate the relative cleaning work done by identical amounts of each cleaner. Pound for pound you get more work through with DC-22 because of its greater reserve power.

When it comes to long-life, the legendary cat with 9 lives has nothing on DC-22. This heavy duty cleaner for iron and steel has unusual reserve power . . . maintains peak cleaning strength even with large amounts of contamination in the solution. More economical . . . because pound for pound you get more work through with DC-22.

A vigorous, heavy duty cleaner, Diversey DC-22 quickly and completely removes all types of solid dirt, oil and grease from iron and steel prior to subsequent operations such as pickling and before and after heat treat. Unusual cleaning action is made possible by superior saponifying, emulsifying, wetting and penetrating power. A dry product, completely soluble in water, DC-22 readily provides a solution of the required strength for tank cleaning.

For liberal experimental sample write Metal Industries Department

THE DIVERSEY CORPORATION
53 West Jackson Boulevard, Chicago 4, Illinois

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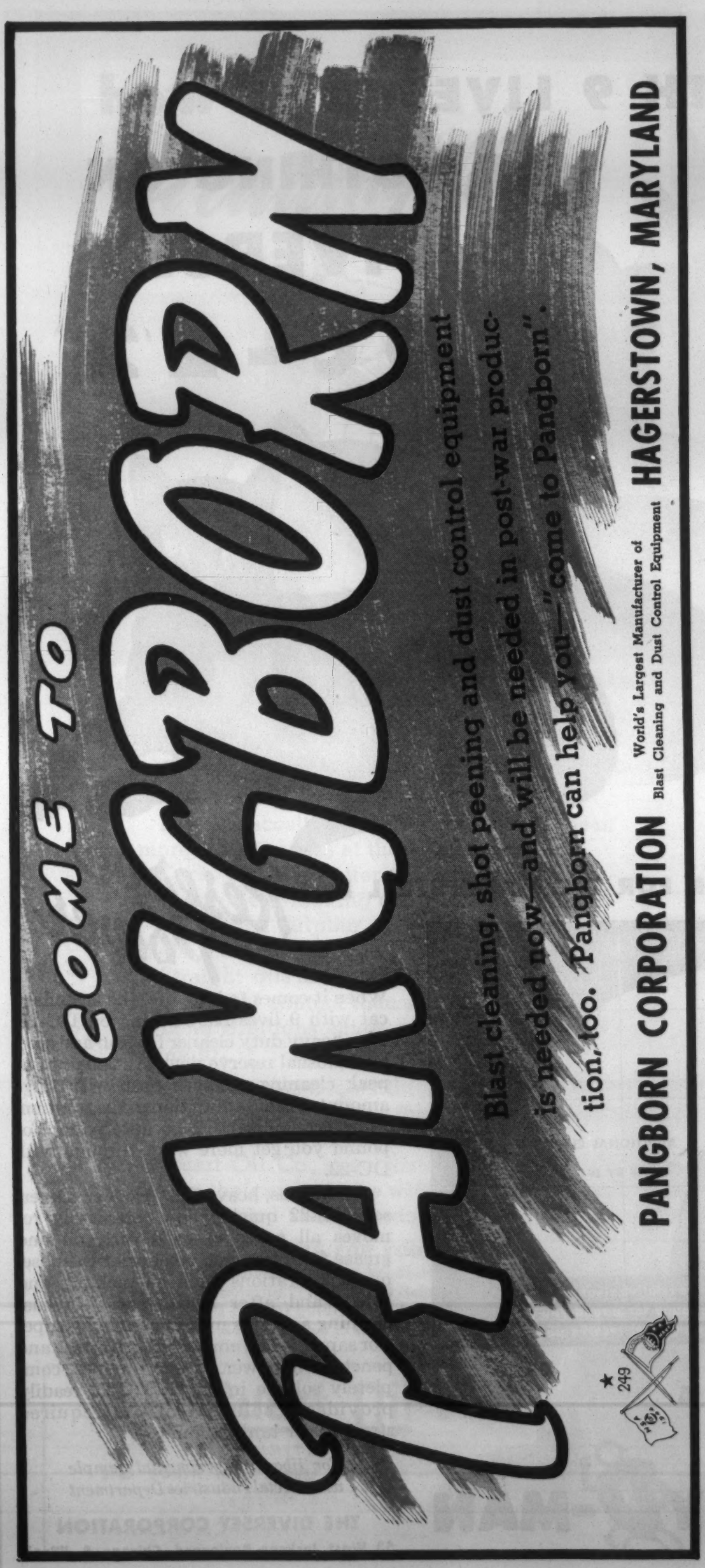
DIVERSEY D-MAN



and emulsification. They are used for either ferrous or non-ferrous alloys, and perform efficiently if the amount of animal or vegetable oils are not excessive. This is a common cleaner for general work.

"Heavy-duty" cleaners are highly caustic and clean almost entirely by saponification. They are for use with ferrous metals only, and will attack and etch the lighter alloys. This type of cleaner is injurious to skin.

Cleaners must be free-rinsing and must have good wetting properties. Certain additions to cleaners, such as rosin, rosinates, sodium silicate, high titer soaps, and bentonite clays, will increase cleaning speed but detract from free-rinsing quality.

The final step in selecting a cleaner consists in actual service tests. Laboratory tests are helpful, but cannot duplicate a shop trial. Any cleaner worthy of consideration should be tested under actual service conditions. Expensive mistakes will be avoided if this rule is followed.

—G. C. Close. *Industrial Finishing*, Vol. 20, Sept. 1944, pp. 34, 36, 38.

Preparing Aluminum for Spot Welding

Condensed from "The Iron Age"

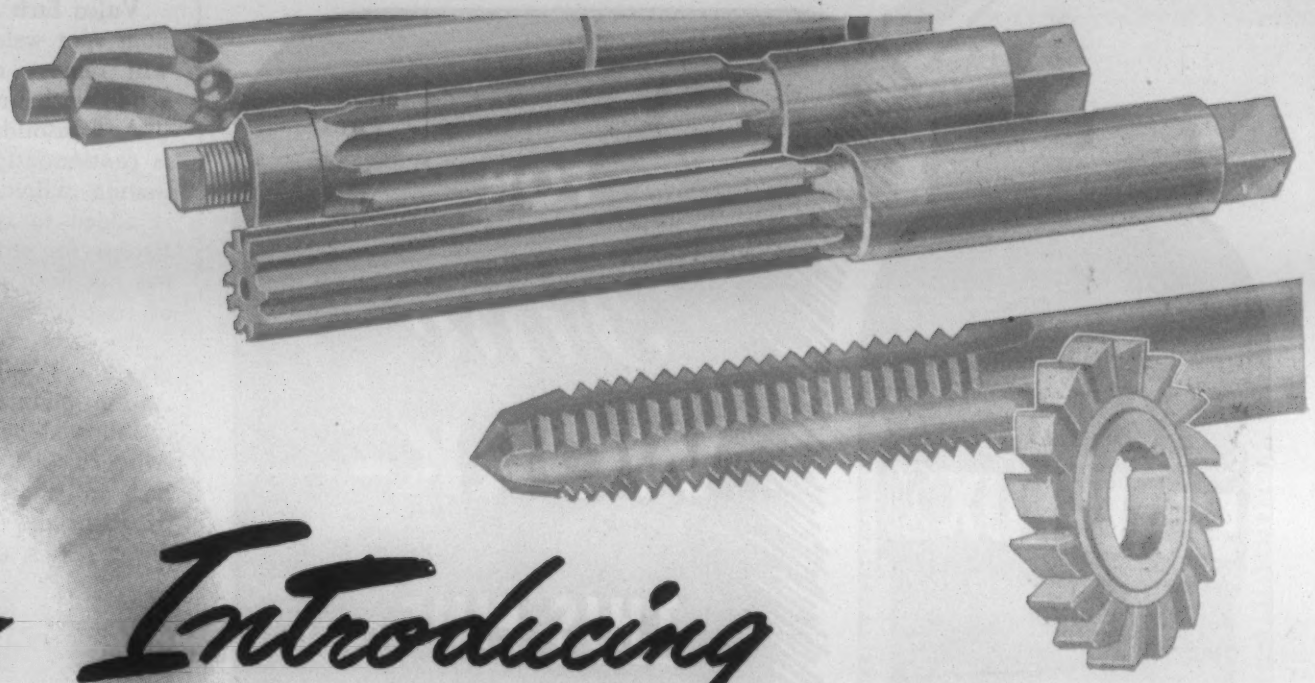
The primary function of surface treatment prior to spot welding is to produce a consistent resistance value to the flow of electrical current. If resistance fluctuates, even at low level, difficulties involved in obtaining consistent welds are multiplied. The high surface resistance of untreated aluminum can be attributed basically to oxide, which forms on aluminum and its alloys exposed to air. It is not the thin oxide formed at room temperature that is the source of trouble, but a heavier and unevenly distributed film deposited during heat treating, forming and drawing.

In order to arrive at an accurate appraisal of various methods of preparing aluminum for spot welding, a means of measuring the surface contact was devised by Consolidated Vultee. The apparatus consisted of two standard ⅝-in. ElkaloyA spot weld tips set in copper blocks, which are installed in a specimen mounting press. A kelvin bridge was used for measuring resistance. Readings were calibrated in spring lbs. from 200 to 2000 p.s.i.

Absolute values were not given for the different methods of treatment, since variations in external circuit resistance in electrode contours may have some bearing on readings obtained. Results produced by wire brushing and by Vulco Etch indicated a slight advantage, at low electrode pressure, of Vulco Etch over wire brushing.

Practically all aircraft spot welding machines have adopted the etch method. This method lends itself to volume production, since a large number of units can be treated simultaneously.

A chemical etch should: (1) Remove oxide without attacking the metal; (2) permit a long, non-critical immersion time; (3) have low surface and interfacial tension; (4) be easily rinsed off; (5) leave a minimum of undesirable residues; (6) be long lived and easily maintained; and (7) be non-hazardous to equipment and personnel.



MO

Introducing STAR-MO M-2

TUNGSTEN-MOLYBDENUM HIGH-SPEED STEEL

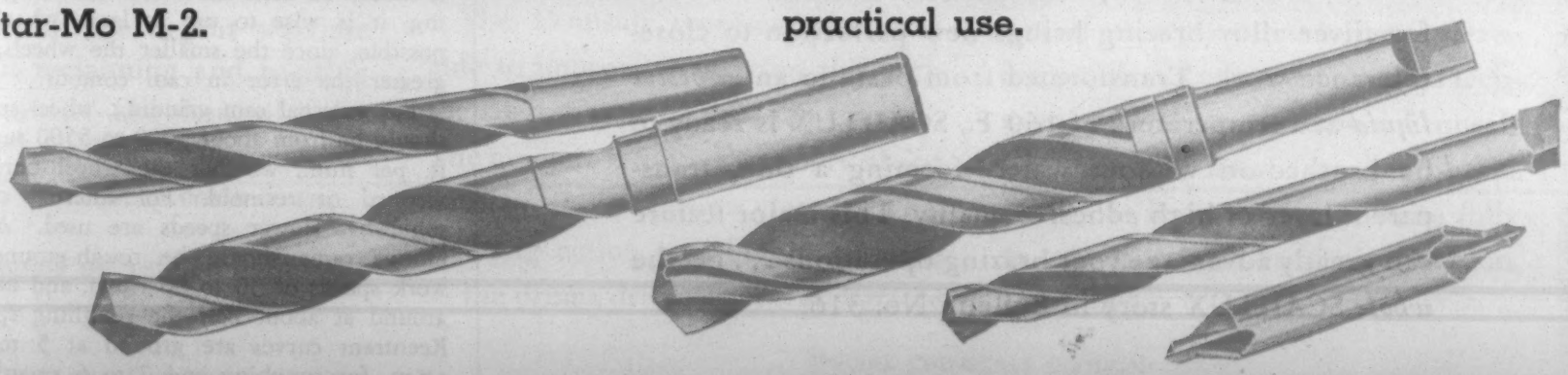
(M-2 ANALYSIS)

During the period of WPB control, Star-Mo high-speed steel conformed to Government requirements, but immediately upon removal of restrictions, late in 1943, an analysis was adopted by Firth-Sterling which was known as "M-2." Since then, all Star-Mo made has been of this new composition approved by leading automotive manufacturers and well-known tool makers. They also adopted the designation "M-2" to describe this type and we included it in the name for this new product —Star-Mo M-2.

STAR-MO M-2 is ***Better.*** On many applications it outcuts and outlasts 18-4-1 high-speed steel—a trial will prove it.

STAR-MO M-2 is ***Cheaper.*** The base price is 14% less than 18-4-1 steels, and in addition Star-Mo M-2 weighs approximately 7% less per foot. May we quote comparative prices?

STAR-MO M-2—is ***Easy to Handle.*** A Firth-Sterling representative will gladly tell you of its value on applications in your plant, methods of heat treatment, and practical use.



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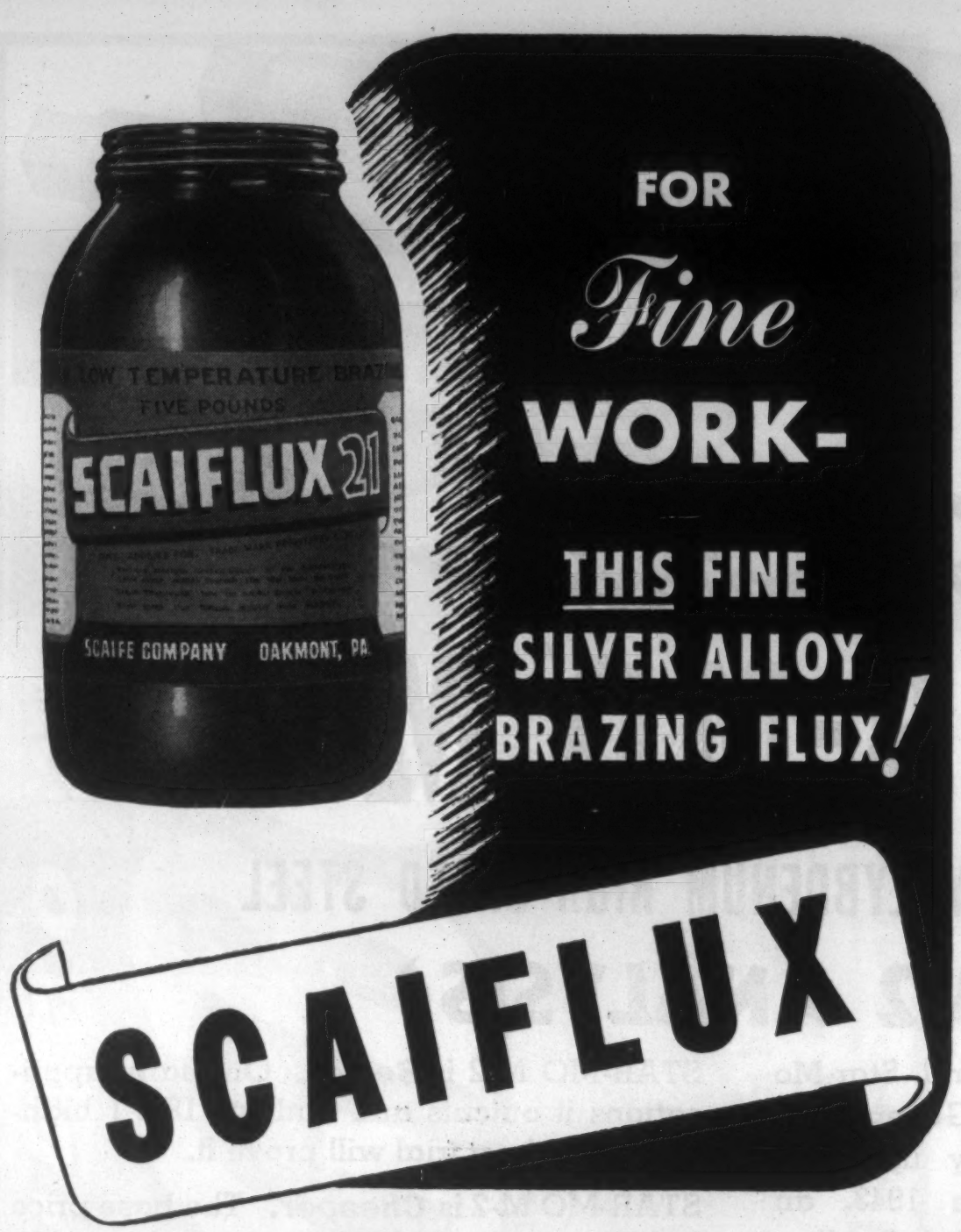

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—ready to solve your Brazing Problems NOW!

This scientifically-compounded, low surface-tension flux for silver alloy brazing brings new perfection to close-tolerance work. Transformed from paste to an *adhesive liquid* at a temperature of 160 F., SCAIFLUX is ready to be brushed-on without water—forming a thin, transparent layer of high adhesive quality. This major feature can greatly advantage your brazing operations . . . get the *whole* SCAIFLUX story in Bulletin No. 316.

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Representatives in Principal Cities

Vulco Etch substantially meets all aluminum spot welding requirements. This etch will remove oxide while minimizing reaction with underlying metal.

At Consolidated Vultee, the etch solution is continuously filtered to remove contaminating matter. At intervals, fresh solution is added to compensate for dragout loss. Except for this maintenance, the solution has not been replaced in more than a year of continuous operation.

As parts are received they are freed of grease and soil in a hot solution of Turco Agiton, maintained at 160 to 185 F. This is followed by a rinse in water at 140 F. After rinsing, parts are immersed in Vulco Etch and then rinsed at 140 F., and dried by warm air.

—S. G. Thornbury. *Iron Age*, Vol. 154, Sept. 28, 1944, pp. 46-49.

Grinding Cam Surfaces

Condensed from "Machinery"

Vibration is one of the most common causes of faulty cam grinding. Where the building vibrates, heavy grinders with separate foundations may be necessary; or, perhaps, tighten or loosen anchor bolts, or apply vibration dampeners—maybe move the machine to another location.

Other vibration causes may be: poorly designed or inadequately maintained machines, loose wheel-spindle bearings, wheel spindles sprung, couplings out of alignment, wheel, motor and spindle assembly out of balance, uneven belt tension, metal belt lacing on spindle drive, idlers loose or out of balance, backlash in driving gears, faulty thrust bearings, loose pulley on spindle, work centers or rests out of true or not lubricated, and improper adjustment of brake on cam attachment.

A common cause of inaccurate cams is failure to realize that the diameter of the grinding wheel used in production must be reasonably close to the diameter of the roller used in generating the master cam. A certain tolerance is allowable.

If a master cam is generated with a 22-in. diam. roller, the grinding wheel may originally have a diameter of 24 in. and be used until worn down to 20 in., when it should be used elsewhere. In cam grinding, it is wise to use as large wheels as possible, since the smaller the wheels, the greater the error in cam contour.

For external cam grinding, wheel speeds should be from about 5000 to 5500 surface ft. per min., whether the wheel bond is vitrified or resinoid. For internal cams, somewhat slower speeds are used. Automotive cams should be rough-ground at work speeds of 30 to 60 r.p.m. and finish-ground at about half the roughing speed. Reentrant curves are ground at 5 to 15 r.p.m. for roughing and 2 to 6 r.p.m. for finishing, depending on the size and contour of the cams.

The wheel should be properly dressed. A fine spiral mark on the cam surface may indicate a cracked or broken diamond; that the dressing was done at too rapid a transverse; that the diamond may penetrate the wheel face too much; or that the tool may be dwelling in contact with the wheel. Set

PENNSALT CLEANER

REG. U. S. PAT. OFF.

HELPS INDUSTRY RECLAIM STEEL DRUMS

CUTTING CLEANING COSTS 33⅓%

MANY MANUFACTURERS are faced with the urgent wartime necessity of reclaiming and re-using metal containers. The demand is for a cleaner that will do a *thorough* job—do it *fast*—and keep costs *down*.

A prominent oil refiner found the answer in a Pennsalt Cleaner.

The problem was to remove various types of oil, grease and solvents from steel drums—and to strip paint from these containers. The operation was carried on continuously in a 1000-gallon drum washer at 145 to 155 degrees Fahrenheit.

Several kinds of commercial cleaners had been tried previously, but cleaning was not satisfactory, rejects ran too high and costs were out of line. The method in practice was the use of an initial charge of 400 pounds of cleaning compound, followed later by an additional 300 pounds.

The Pennsalt representative was able to improve greatly on this with the correct type of Pennsalt Cleaner. The amount required was only about 35% of the previous cleaner. The cleaning action was highly effective—the drums dried faster—and grease containers could be included in the cleaning operation, an advantage not previously possible.

What's more—*careful comparison of costs showed that Pennsalt Cleaner was saving this plant 33⅓ percent!*

That's a saving that should interest you, if your plant has a metal cleaning problem. Let our experienced technical staff show *you* how a Pennsalt Cleaner will help you get better results at lower costs. Or write fully to our Special Chemicals Division, Dept. MA.

SPECIAL CHEMICALS DIVISION

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NU-BRAZE silver brazing alloys have proved their value in 24 hour war production. Silver brazing "Know-how" can keep you ahead of peacetime competition ...make your product lighter, stronger, less costly by simplified NU-BRAZE construction. A NU-BRAZED joint is a selling point!

Silver brazing alloys for government and A.S.T.M. specs; other NU-BRAZE alloys for individual needs. In planning post-war production, eliminate costly methods of riveting, tapping and threading, etc. Use NU-BRAZE, the modern silver brazing technique of metal joining. A NU-BRAZED joint is leak-proof... non corroding... electrically conductive...vibration and shockproof. We'll analyze your problems;—return NU-BRAZED parts with recommendations, specifications, and alloy samples. No charge, No obligation!

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CLIP THIS COUPON FOR TEST SAMPLES

Please forward at once generous test sample of your

NU-BRAZE GRADE III ☐
1300°F. silver-phosphorous alloy for joining copper, brass, bronze

NU-BRAZE GRADE VI ☐
1175°F. easy-flowing alloy for joining like or unlike ferrous or non-ferrous metal and alloys

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the tool downward at an angle of 5 to 10 deg. Turn the diamond in its holder at regular intervals. Hold the holder and tool tightly.

Too hard a wheel may cause chatter marks or burning and cutting too slowly; too soft a wheel may cause wide irregular marks of varying depth and grit marks. Too coarse a grit may cause narrow and deep scratches; too fine may cause the wheel to load and glaze.

—Paul Stoner. *Machinery*, Vol. 51, Sept. 1944, pp. 163-166.

Weld Cracking of Alloy Steels

Condensed from "Metal Treatment"

Susceptibility to cracking of welds in alloy steels was evaluated by means of the R. D. Rigid Butt Joint Weldability Test. In this test a restrained butt joint is made in which the restraint is varied by varying the width of the plates behind the butt weld. A standard test procedure was used except for the width of the plate, which varied from 2½ in. (minimum restraint) to 6 in. (maximum restraint).

The initial tests were made with various austenitic electrodes (19 Cr, 9 to 10% Ni, with molybdenum and/or manganese) on alloy steel plate up to ⅜ in. thick (0.3 C, 3.5 Ni, 1.25 Cr, 0.25% Mo). Even when the composition of the weld deposit was approximately the same, there was considerable variation among the electrodes in their tendency to induce cracking.

Baking at 640 C. for one hr. to remove hydrogen, contained in the electrode coating in the form of absorbed water, combined water or organic materials, made the poor electrodes fully equivalent to the good ones. With some electrodes, a baking at 105 C. was sufficient. Likewise, the good electrodes could be made very susceptible to cracking by adding hydrogen, either by introducing kaolin and sodium silicate into the coating or by directing a jet of hydrogen at the arc from close range.

Chemical analysis showed (1) the good electrodes had lower total hydrogen or lower hydrogen in combined form than the poor electrodes; (2) the poor electrodes improved by baking at 105 C. had a water content that corresponded to a high proportion of the total hydrogen content; (3) the poor electrodes improved by baking at higher temperatures had a combined hydrogen content corresponding to a high proportion of the total hydrogen content. These experiments tended to confirm the hydrogen hypothesis.

Attempts made to decrease the hydrogen content of ferritic electrodes by baking at 640 C. were unsuccessful, as the coating was either cracked badly or the running characteristics were seriously altered. Experimental ferritic electrodes were, therefore, prepared with low total hydrogen and with increasing amounts of hydrogen. The low total hydrogen electrodes showed the same freedom from cracking as commercial oxidized ferritic electrodes. Likewise, as the hydrogen increased, the susceptibility to cracking increased, with the most marked effect being shown in the cellulose coated electrodes.

it's impossible!

time was when it was considered impossible to spot weld heavy gauges with a *balanced three-phase load* . . .

"THREE-PHASE" WELDING

now provides the answer!

Both manufacturers and power companies have long torn their hair over the problem of spot welding heavy gauges. Conventional AC single phase welders cause serious disturbance to the usual three-phase power supply, operate at low power factor because of the heavy reactive load, and demand high power due to the high secondary resistance.

In announcing the "THREE-PHASE", Sciaky presents a method of resistance welding heavy gauges which effectively solves these problems. By employing an ingenious system of rectification and reconversion, Sciaky welders now ***operate on a balanced Three Phase load at near unity power factor (use less KVA).***

Watch for subsequent announcements explaining the operation of the "THREE-PHASE."

SCIAKY BROS.

Manufacturers of a Complete Line of AC and DC Electric Resistance Welding Machines

4915 West 67th Street Chicago 38, Illinois

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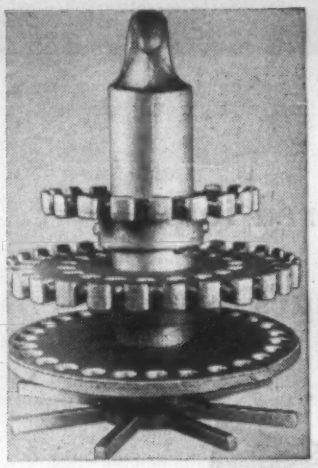
In England: Sciaky Electric Welding Machines, Ltd., London

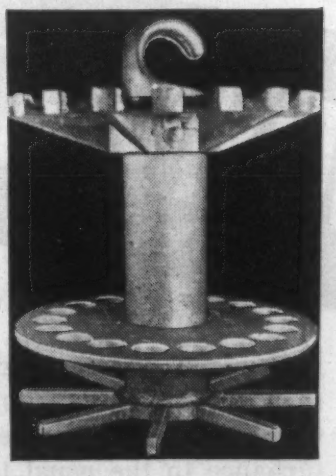
In France: Sciaky S.A., 13, 15 Rue Charles Fournier, Paris

WHEN EXTREMELY ACCURATE SUPPORT IS REQUIRED SEE *Sterling*



These are carburizing fixtures used for holding light slender gears for airplane engines. Because of the temperature at which these parts are treated, they must be precisely supported. Irregularities or imperfections in the fixture would cause distortions which, though slight, would destroy the usefulness of the gears.

Specially designed by Sterling, these and scores of other precision fixtures are helping to speed war production. Let Sterling help with *your* problems.



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The question then arose as to why austenitic, killed ferritic and oxidized ferritic electrodes with the same amounts of hydrogen had different susceptibilities to cracking. It was believed that the difference must be in the degree of retention of hydrogen.

In preliminary tests, a killed ferritic deposit evolved 2 to 3 times the volume of gas (over 95% H) on cooling as was evolved by the experimental low hydrogen ferritic deposits which, in turn, evolved 2 to 3 times as much gas as the oxidized ferritic deposits. Little or no gas was evolved from austenitic deposits.

—G. L. Hopkin. *Metal Treatment*, Vol. 11, Summer 1944, pp. 125-130.

Electropolishing

Condensed from "Monthly Review," American Electroplaters' Society

Electropolishing processes are now available for polishing the common metals, including steel, stainless steel, nickel, copper, aluminum, brass, Monel, etc., on a production scale. The most obvious application for electropolishing is finishing for appearance.

The polishing of articles of intricate shape, not easily accessible to wheel polishing, is one likely application. The polishing solutions used are of the sulfuric-phosphoric acid type, in some cases also containing chromic or perchloric acid. For details of bath operation, reference is made to the patents on the solutions. In some solutions arsenic acid is substituted for phosphoric acid, but the phosphoric acid baths are superior.

Full luster is usually obtained with about 0.001 in. metal removal, which requires a processing time of 8 to 30 min. The operating current density is usually 100 to 500 amp. per sq. ft., and the temperature range is 115 to 150 F. Many other electropolishing solutions have been reported, but it is considered that for broadness of applicability and ease of operation, the sulfuric-phosphoric acid baths are best from a commercial standpoint.

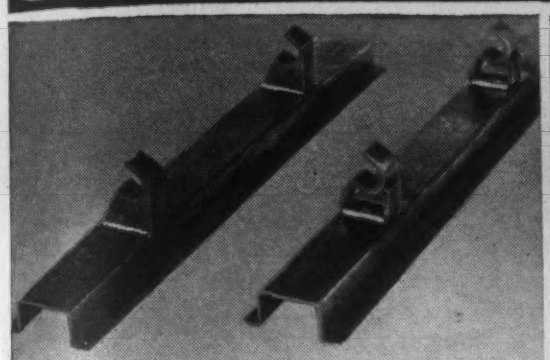
There are two classes of baths: (1) those with infinitely long operating life where (a) metal plates out on the cathode at the same rate that it dissolves from the anode, (b) where insoluble metal sulfates form without hindering operation; and (2) those possessing a finite life and which have to be discarded at a dissolved metal concentration of 4 to 5%. Baths containing chromic acid initially or to which it is added by the work, *e.g.*, stainless steel, have a finite life.

Rack design, equipment, etc., are similar to those used for chromium plating. Generators or rectifiers of 12 to 15 v. are needed, though for broadest use 18 to 24 v. sets may be desirable.

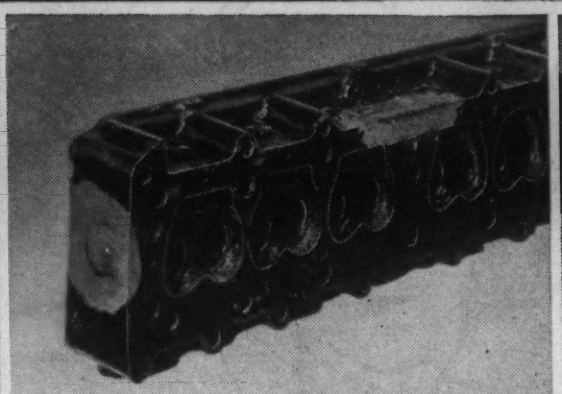
Electropolished stainless steel is more corrosion resistant than wheel polished and nitric acid passivated metal. Electropolishing as a machining operation is being used commercially. Electropolishing of a basis metal in preparation for electroplating is of particular advantage where a heavy plate is to be applied for mechanical or engi-

(Continued on page 1686)

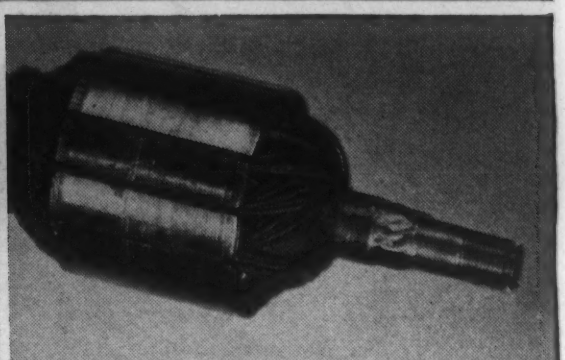
AVOID WELDING DISTORTION STRESSES AND OVERHEATING



Arc welding bombsight hanger on frame member of plane produced severe warping and misalignment. Eutectic Low Temperature Welding prevented distortion and formed strong joints.



Cast iron motor heads are safely repaired without danger of subjecting to stresses, eliminating need for costly and lengthy after machining always necessary to correct distortions.



Worn motor armature shaft resurfaced by Eutectic Low Temperature Welding completely avoiding warping of shaft and preventing destruction of windings by excessive heat.

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● Illustration shows typical centralized installation, designed to serve a large number of machine tools. Other Hoffman models are available for installation on single machines.

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neering reasons. This procedure gives maximum adhesion of the plated metal, since the plate is applied to a strong basis rather than to a weak machined layer.

Electrobuffing of plated metals is entirely practical and generally removes no more than 0.0002 in. of metal to achieve full color.

—C. L. Faust. *Mo. Rev.*, Am. Electroplaters' Soc., Vol. 31, Sept. 1944, pp. 807-815.

British Electrolytic Copper Powder

Condensed from "Metallurgia"

Before the war Britain imported 500 to 1000 tons of electrolytic copper powder a year for use in porous bronze bearings and motor and dynamo brushes. Only within the last year has this powder been produced in Britain.

Three main types of powder are being produced in Britain: (1) coarse, 40 to 100 mesh, loading weight (apparent density) 2.2 to 2.6 g. per c.c., flow factor 100 g. through a 0.177 in. diam. orifice in 18 sec.; (2) M (about equal to American grade B, heavy quality), 25 to 35% 100 to 200 mesh, 20 to 30% −200 to +300 mesh, and 40 to 50% −300 mesh, loading weight 2.7 to 2.9 g. per c.c., flow factor 100 g. through a 0.177 in. diam. orifice in 13 to 15 sec.; (3) extra fine (about equal to American grade C), about 100% −300 mesh, loading weight 2.0 to 2.5 g. per c.c., no flow factor. Type M is used for porous bronze bearings and is an ideal free flowing powder. The extra fine is used for diamond tools, etc.

There are only three commercial methods of making copper powder: electrolytic deposition, gaseous reduction of copper oxide, and atomization. Atomization gives a spherical powder, hard to compress, requiring high die pressures and causing high die wear. Although atomized powder is widely used in the chemical industry, it is little used in powder metallurgy except for applications such as porous filters where no outstanding physical properties are required.

Both electrolytic and gaseous methods give spongy porous particles of irregular shape, but the latter is supposed to give a powder somewhat less stable against atmospheric oxidation and causing slightly higher die wear than the former.

A fine powder (for example, −300 mesh) is best for non-porous compacts, while coarser powders are preferred for porous products or for hot pressing. The particle size distribution curve can easily be determined by sieving if the powder is +300 mesh (attention is called to the appreciable differences between U.S.A., I.M.M. and B.S.S. sieves).

If the powder is −300 mesh to 1 micron, complex elutriation methods, of which there are many, are required. In some cases, the proportion of fine particles from 1 to 10 microns has a critical effect on the behavior during sintering, especially if a liquid phase is present.

In mass production, where the amount of powder per cycle is measured by volume, it is essential to keep the loading weight constant. Free flowing characteristics are important with mechanical presses, but not with non-mechanical high-speed presses.

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Ebonol-C, the chemical process for blackening copper and its alloys, combines beauty with corrosion protection, chemical stability and durability. Brilliant, shiny black finishes can be obtained on buffed copper or brass. Dull non-reflective blacks can also be achieved.

Due to the ease of application, Ebonol-C is replacing black nickel, sulphide blackening and enameling. Ebonol-C is pre-eminent whenever *quality* of black is wanted. It is an oxide—part of the metal itself—and does not flake or chip off. *Write* for new 8 page Bulletin. The Enthone Co., 448 Elm St., New Haven 2, Conn.

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The advice and help of Barrett technical service men are available to you for the asking.

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Free: An interesting and helpful booklet, packed with useful information about Anhydrous Ammonia, will be mailed to you free on request.

To obtain these properties, the powder must be comparatively coarse, as there is little or no flow if over 60% is −300 mesh. Therefore, free flowing can be obtained only at a sacrifice in some other property.

—H. W. Greenwood. *Metallurgia*, Vol. 30, Aug. 1944, pp. 181-184.

Protective Coating for Steel

Condensed from "Steel"

The Iridite process for improving the corrosion resistance of zinc-plated, cadmium-plated, and galvanized surfaces produces a film containing chromium compounds. The finished product is uniformly covered with an opaque, olive green coating. The luster and smoothness of the finish depend on the character of the underlying surface.

The Iridite bath contains bichromate salts and is acidified with an organic acid, which supplies the acid component of the bath and accelerates the reduction of a large amount of chromium to its lower valence. Other metallic salts added to the bath control the extent to which the reduction goes and thus maintain uniform color. Thickness of the coating is about 0.00004 in. It is possible to treat the film before drying in such a way as to throw down within it a colored precipitate.

The protective film has a relatively low abrasion resistance, is relatively but not absolutely insoluble, and adheres perfectly to the base metal. Exposure at 200 to 250 F. for extended periods reduces the corrosion resistance. Acid fluxes, not resin fluxes, should be used in soldering connections to a treated part. Paint adheres excellently to the film.

Iridite coatings may be exposed to normal moist atmospheres for long times without showing any change. When subjected to salt spray, they will remain unchanged for 150 to 500 hr. The color tends to lighten or fade after months of outdoor exposure, without significant change in susceptibility to salt spray.

Chemicals for the bath are shipped in carboys, in concentrated form, and diluted with eight parts of water to make the operating bath. Tanks may be constructed preferably from acid-proof brick, or glass brick, or lined with one of several synthetic materials. Steel and lead are attacked by the solution. The temperature of the bath should be kept at about 75 to 80 F. Below 70 F., the rate of reaction is reduced, and above 90 F., a much lighter color is produced.

Parts to be finished must be as clean as for plating. They are immersed in the Iridite bath for 10 to 60 or more sec., depending on the age and temperature of the solution, or on requirements of production. They are given a cold water rinse, followed by a warm water rinse to facilitate drying. Any suitable drying means may be used, but the temperature should not exceed 200 F.

Before finishing zinc die castings, they must be given an adequate caustic cleaning. Small die-cast parts are most easily handled by giving them a brief flash plating in a zinc cyanide bath. Immersion cleaning in a hot bath of cyanide and caustic without electrolysis is also satisfactory.

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Harmomang is an electrode with the work-hardening qualities which suit it especially for the building up or hard surfacing of manganese and carbon steels.

It is a coated moly-manganese electrode with a hardness range up to 43-46 Rockwell "C". It can be used on AC, or for either straight or reverse polarity on DC.

Harmomang is the ideal electrode to use wherever you need protection against both impact and abrasion. For example: for hard surfacing dipper lips, dipper teeth, bucket runners, rock crushers, railway frogs or wherever longer life is desired for parts made of manganese or carbon steels.

Write direct for full information and procedures or see your P&H representative.

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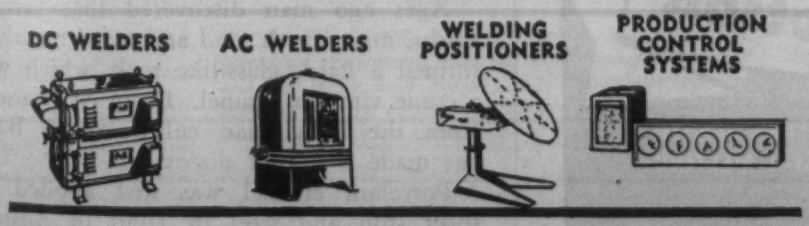

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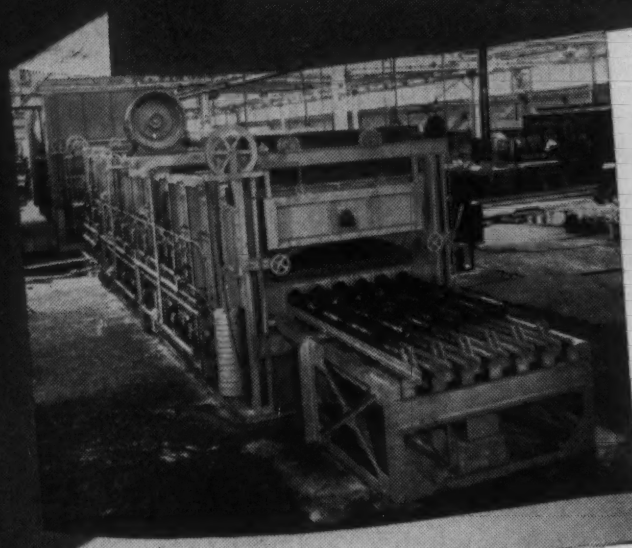
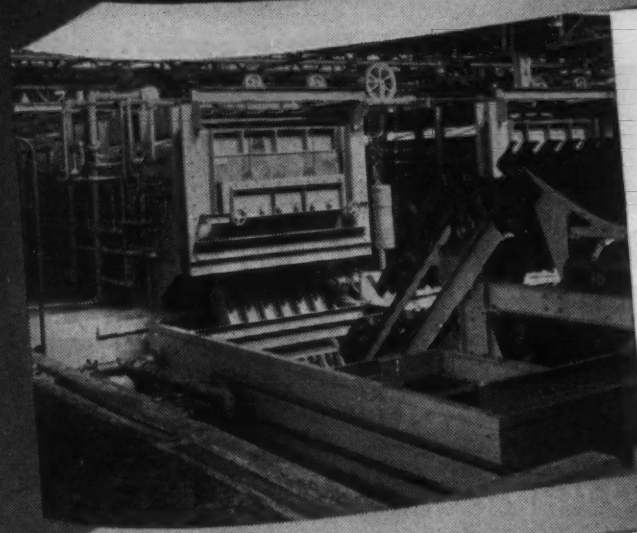
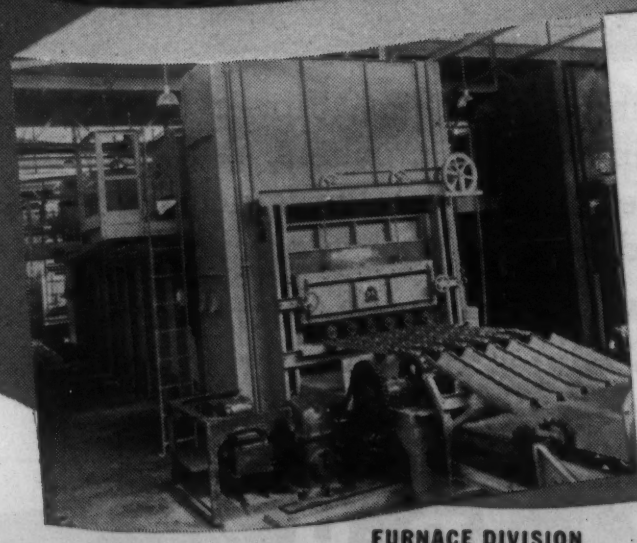


Unexcelled engineering ability in the production of heat-treated heavy artillery shells is exemplified by this automatic, gas-fired R-S installation. The shells are pushed through the hardening furnaces in six parallel conveying tubes.



Shells are quenched internally and externally, then leave the quench tanks on continuous conveyors.



The draw furnaces, through which the shells move on alloy chains. The result is uniform heat-treatment and low cost production.

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Hot-dipped galvanized steel requires a special bath with a somewhat higher chromium concentration. A lusterless finish is not so easy to attain, as the bath accentuates the spangles.

Replenishment of an Iridite bath is not recommended when it has been used to depletion. The pH of a fresh solution is 1.6 to 1.7, while that of a depleted solution is 3.2 to 3.4. Maintenance of pH by acid additions does not significantly prolong the working life of the solution. Average coverage of bath on plated parts is 15,000 to 22,000 sq. ft. per 100 gal.

—R. M. Thomas. *Steel*, Vol. 115, Oct. 2, 1944, pp. 74, 76, 78, 118, 120, 122, 124.

Welding of Rare Metals

Condensed from "Zeitschrift für Metallkunde"

Gold is used for lining apparatus and fittings, usually in thicknesses of 0.25 to 0.50 mm., and still less in gold-plated materials. Hammerwelding is employed practically exclusively.

The places to be welded overlap about 3 mm., are spot-welded for tacking, and then welded with the oxyhydrogen flame with some hydrogen excess; the hydrogen should be purified to avoid a sooty flame. After preheating to 100 C. (212 F.), hammerwelding is done at 950 C. (1740 F.). Fusion welding is used only if hammerwelding cannot be applied; the addition should be the same material as the gold to be welded.

Platinum, usually of 99.5% purity, and of 0.25 to 0.50 mm. thickness, is also hammerwelded but at 1350 C. (2460 F.), and if necessary, fusion welded, both with the oxyhydrogen flame. Platinum-plated steel is welded with a gold-foil.

Silver is used in solid form or in linings and in silver-plated materials. Hammerwelding is difficult, due to oxygen absorption from air at higher temperatures. The overlap here is 6 to 10 mm., and the welding zone is heated by an illuminating gas flame to 850 to 900 C. (1560 to 1650 F.).

Fusion welding with the oxyacetylene flame is mostly used, but the burner must be larger because of the great heat conductivity of the silver. The flame should have a slight acetylene excess to avoid oxygen absorption.

A well-made silver weld is perfectly dense and free of pores. Silver-plated materials are welded preferably with the electric arc.

—K. Ditterich. *Z. Metallkunde*, Vol. 22, May 20, 1943, pp. 276-280.

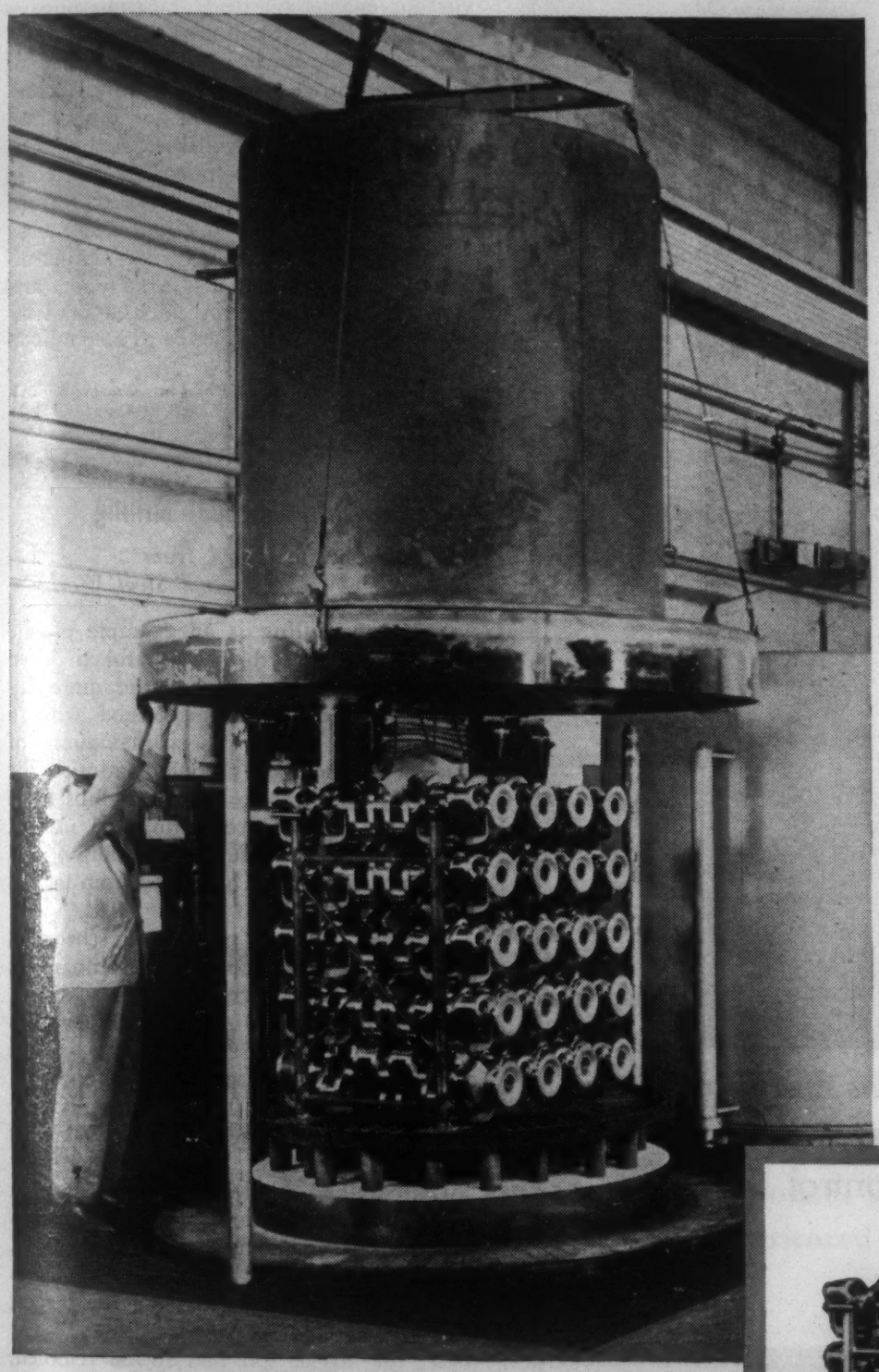
Porcelain Protection Against Corrosion

Condensed from "Finish"

Ages ago man discovered that certain earths, mixed with sand and fused together, formed a hard, glass-like rock, which was a crude vitreous enamel. Every civilization, from the Babylonian culture 7000 B.C., has made a similar discovery.

Porcelain enamel was first applied to sheet iron and steel in 1850 in Austria and Germany. Advancements in technology

Packard reports:
EXCELLENT RESULTS FROM INCONEL HOODS and RACKS in nitriding of Rolls-Royce crankshafts



Late in '41, Packard installed modern equipment for nitriding crankshafts for Rolls-Royce aircraft engines.

The hoods are made of Inconel sheet . . . welded *gas-tight* to confine the dissociated ammonia. The carrying racks are welded from Inconel tubing and bar.

Examined recently . . . after almost 2½ years of severe service . . . neither the hoods nor the racks show sign of deterioration.

Inconel, a high nickel-chromium alloy, does not absorb nitrogen from the dissociated ammonia and is thus free from embrittlement. At the nitriding temperatures of 900° to 1100° F., Inconel has the necessary resistance to oxidation as well as high strength and ductility.

For further information about the properties and uses of Inconel, address:

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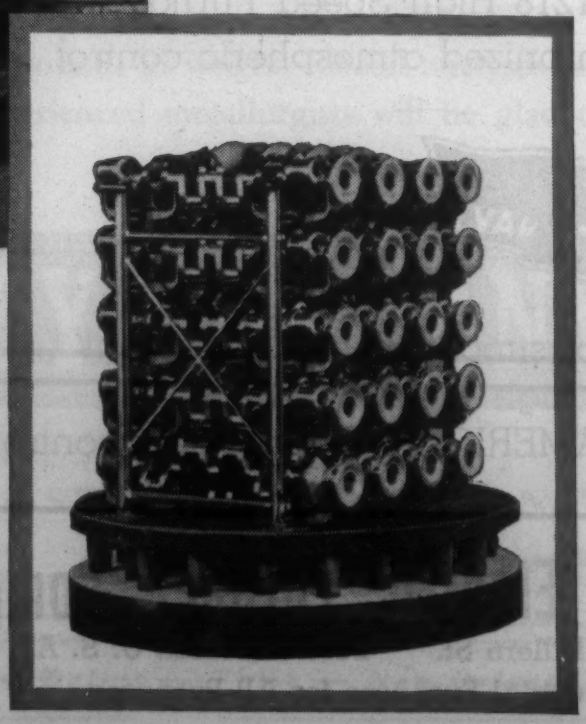
NITRIDING CRANKSHAFTS FOR ROLLS-ROYCE AIRCRAFT ENGINES. *The Inconel hoods and carrying racks are exposed to dissociated ammonia at 900° F. . . . give no evidence of deterioration from oxidation or scaling, or embrittlement. The welds are as sound as the parent metal.*



INCONEL RACK *loaded with crankshafts for nitriding treatment. Inconel equipment is readily welded from mill forms . . . is especially recommended where equipment must maintain strength and resistance to oxidation at high temperatures.*

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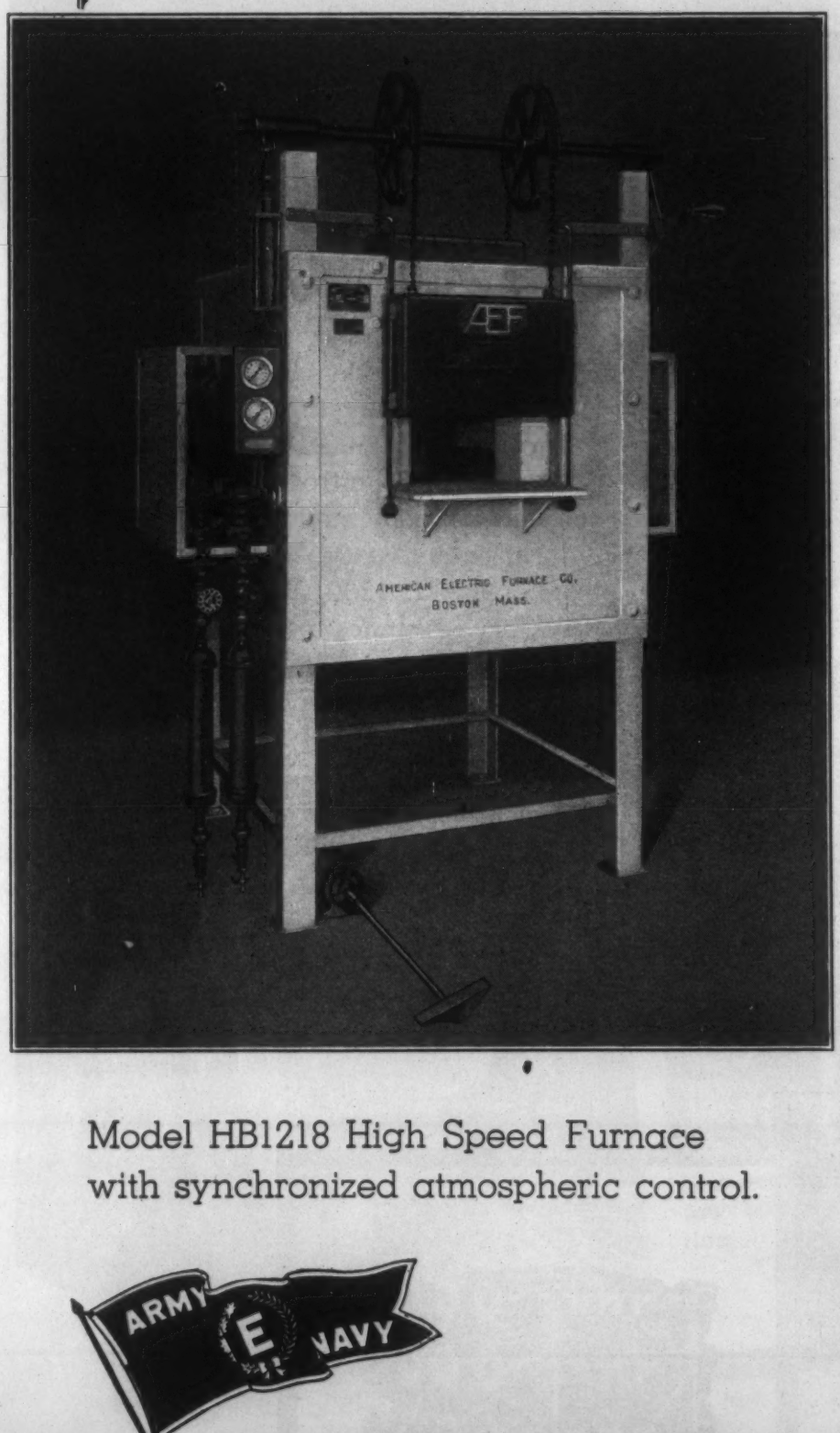

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helped develop porcelain enamel into a fast expanding modern industry.

Vitreous porcelain enamel on steel has proven its usefulness in the manufacture of many household products such as refrigerators, stoves, kitchen sinks, table tops, bathtubs and a host of kitchen ware. Wide developments have been made in the field of architectural porcelain on steel over the past four decades.

There has not only been an improvement in the drawing qualities of the steel, but there has been an amazing development in acid resisting and permanent wet process vitreous enamel on steel. Lustrous finishes can be made in any desired color or finish.

Experience gained in the production of one-piece porcelain enameled ware, including enameled steel bathtubs and other similar products, is now available for the fabrication of deep-drawn one-piece porcelain enamel steel caskets. Such a casket, formed in metal porcelain enameling stock, fired with an imitation mahogany or mother-of-pearl porcelain finish inside and out, and decorated inside with any color of silk-like-fiber-glass fabric, is suggested as a completely permanent casket.

—C. J. Rodman. *Finish*, Vol. 1, Oct. 1944, pp. 17-19, 44.

High-Speed Spar Milling

Condensed from
"Western Machinery and Steel World"

Spar cap milling is an example of the way in which Northrup has broken down its processing so that even the more involved operations are performed with a minimum of effort and a maximum of efficiency. The spar supports and ties the wings to the fuselage. Modern ships have two heavy spars, necessitating the use of heavy spar caps. These are aluminum alloy, originally designed to be milled from forged billets.

In order to meet production schedules, die forging was adopted to eliminate as much metal as possible before machining, and the Onsrud A-80-A, a spar miller with twice the horsepower and capacity of the earlier model, was procured. Cutters, utilizing speed up to 10,000 surface ft. per min., were developed and new machinists trained to use them.

Die trouble developed in the forging shops, as the aluminum alloy forging was 112 in. long and a little over 5 in. x 7 in. in cross section, until the Bohn Aluminum Co. formed extrusions that are the largest of any metal in the Allied world. To use these, the whole job had to be retooled, but then production curves rose from four caps a week to a daily shift average of 12 and a high point of 22 in one 10-hr. shift from one Onsrud machine.

The Onsrud spar millers have a length of 30 ft. in two 15-ft. bed-sections. Additional bed sections 15 ft. long may be added. Spars 362 in. long have been milled on a bed of 60 ft.

The 30-ft. two-section combination is of the stationary bed type with traveling carriage, actuated by a helical rack. The rate of feed is controlled by a Thymotrol, which permits variation of feeds between 0 and 200 in. per min. This miller has two horizontal arbors with speeds of 2900

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DURASPUN High Alloy Centrifugal Castings approach forged steel in tensile strength, have metal structure free from casting faults, and offer amazing dimensional accuracy. And the alloying elements, chromium and nickel, give a resistance to corrosion, abrasion, and temperature that forged steel cannot match.

Tubes, shells, jackets . . . almost any cylindrical shape can be cast centrifugally from high alloy metals by the DURASPUN method. The one requisite is a "circular" hole, extending through the length of the piece. In regular tubing, the walls are uniform in thickness, with true outer and inner concentricity. Irregular shapes may be cast, with smooth walls or with grooves, flanges, cleats, splines, etc.

Individual castings range up to 8000 pounds in weight. Metal analyses are selected to suit your needs. Our experienced metallurgists will be glad to advise you in any way desired.

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Despite unprecedented demands, the shortage of help and transportation difficulties, many customers receive their shipments of Armour's Anhydrous Ammonia *within 24 hours.* That is service!

It's the kind of service *Nitriding requires...* for when a metal-treating plant needs ammonia, it needs it fast. And *sixty-five stock points* strategically located throughout the country make prompt emergency deliveries possible.

In attaining this superior speed in servicing, *nothing has been sacrificed in product* performance. Armour tests every single cylinder for *product purity.*

Such unusual precautions to protect product quality as well as the unmatched set-up for service are typical of how Armour's 55 years' experience can be especially helpful to you.

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r.p.m. driven directly by two 60-h.p., 50-cycle motors and two vertical arbors driven by individual 15-h.p. high-cycle motors to a speed of 10,000 r.p.m.

The motors may be controlled individually or collectively. Ammeters on the horizontal motors show their safe limits and have shown that larger motors can produce even greater efficiency. In a short time 100-h.p., 50-cycle motors will be installed.

The cut of each arbor is controlled from its own form bar, a part of the milling feature. They are of steel, an exact replica of the finished spar, interchangeable from fixture to fixture, and changed for each cap.

The basic problem is to hold the cap rigidly while being milled. A 15-foot cast steel fixture is clamped to the bed. The rough spar cap extrusion is placed in the center of it. Hinged jams, on the left side of each of the 13 clamps, contact the cap, applying a force of approximately 2000 lbs. per clamp. Any lessening or stoppage of the air pressure on the clamps cuts off all power.

After the first extraction of metal the natural metal stresses within the extrusion become active, and when the caps are released from the clamps, warpage as great as three in. in the 112 in. length appeared. It was found, however, that further milling, on the opposite side, brought the cap to within ¼ in. to ½ in. out of plane. This is straightened on a Farquhar press.

—G. B. Ashmead. *Western Machinery & Steel World*, Vol. 35, Sept. 1944, pp. 366-373.

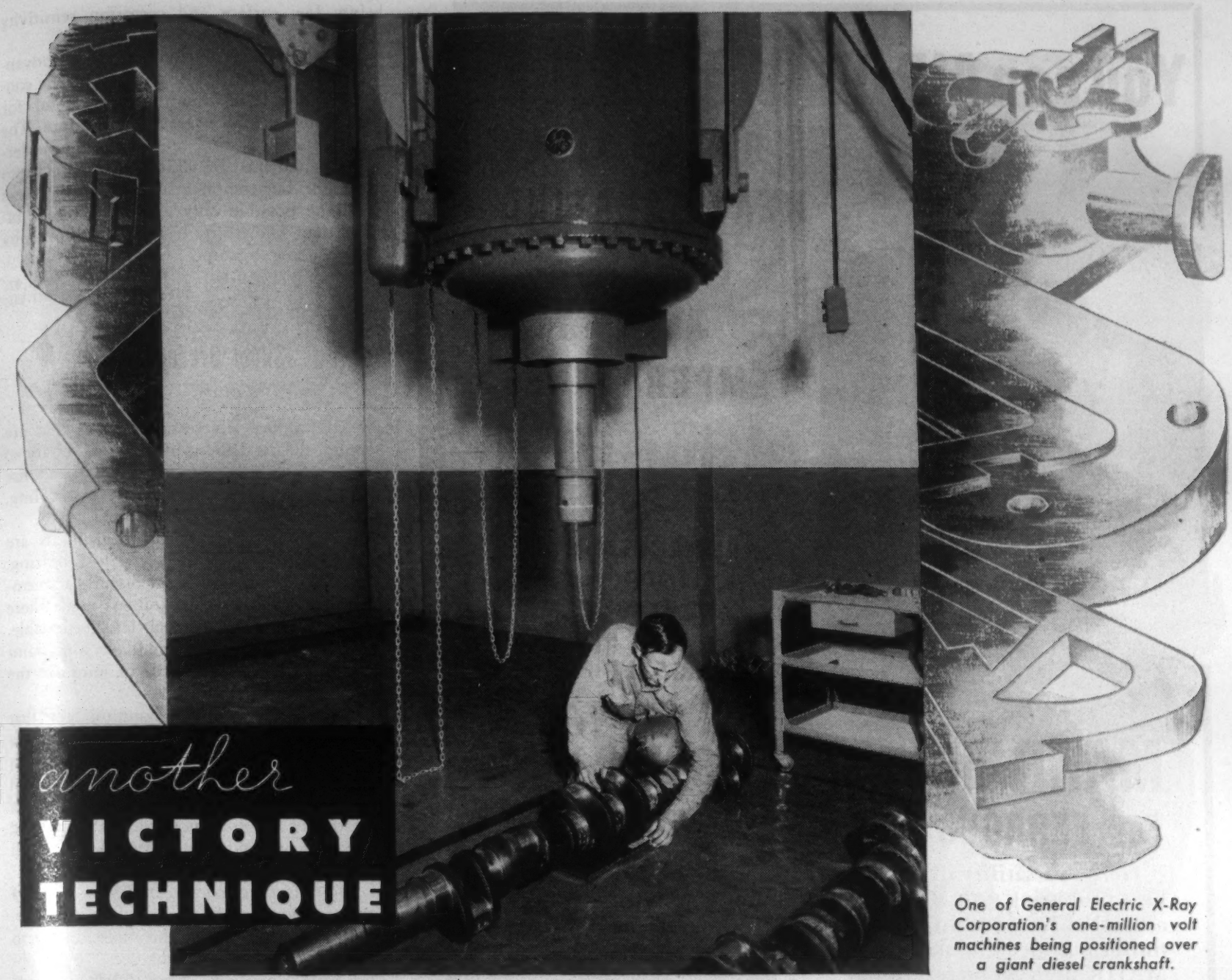
Stresses in Die Casting Molds

Condensed from "Zeitschrift Ver. deut. Ing."

In the die-casting process, the material of the mold is subject to very high stresses, both mechanical and thermal. The magnitude of these stresses could not be determined directly, but became obvious by the behavior of the material as the surface showed, after a certain time, a net of fine cracks that finally rendered the mold useless. A series of tests was made to find the effect of the casting process on the material, and then to find some numerical bases for the magnitude of the stresses.

The most remarkable results were that the temperatures measured in the surface of the mold exceeded, in some places, the temperature of the liquid metal before casting, *i.e.* 610 C., by 40 to 70 C. This is explained by the liquid metal being forced with high pressure through the gate, and thus the frictional forces increase temperature of both metal and mold. And the high velocity of the temperature increase, measured to more than 300 C. in less than 1/1000th sec., acts like an enormous impact on the material, which produces very high surface tensions and can cause fatigue fractures.

The formation of cracks can be suppressed by low pouring temperature, high average temperature of the mold, uniform moderate cooling, and steady operation; by proper design of the mold, *i.e.* uniform distribution of cooling channels, no additional cooling of particularly hot spots, and dense surface quality; and further by correct selection of the material. It should possess a low heat expansion coefficient, high fatigue strength at high temperatures, high damp-



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One of General Electric X-Ray Corporation's one-million volt machines being positioned over a giant diesel crankshaft.

X-RAY NOW REVEALS HIDDEN SECRETS OF METAL

Most mysterious of new war-promoted metallurgical processes, the inspection of metallic structures by ever-more-powerful x-rays is one of the most practical. Inspired by the demands of army and navy, the production of all kinds of war equipment and munitions thus has not only been speeded up to unheard of proportions but safety and dependability in performance have been increased many times over.

Making spot checks on castings, developing routine casts, inspecting welds, or operating on a production line basis, x-ray machines powered up to two-million volts are giving certainty to a metallurgy previously working in the dark.

One out of many Victory Techniques that are helping to win the war, the new x-ray technique is typical of the processes, treatments, methods and assemblies that industry must adopt in order to produce competitively in peacetime at low cost and make jobs for everybody. *You must learn what these new techniques are.* Talk with the experts who call on you—your machine-tool man, your electrical equipment representative, your contact people for materials and services of every kind.

Your Lindberg Furnace representative can help you in ways you may not suspect. Invite him to talk freely about your metallurgical problems.

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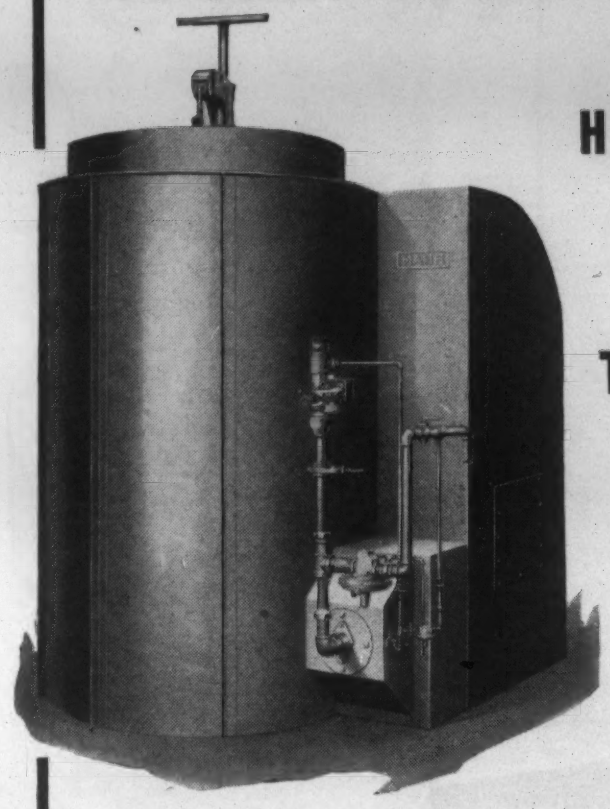

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Here's versatility in this MAHR convection heated, cylindrical heat processing unit. Gas or oil fired. Efficient burnering supplies a flood of heat within the heater which is distributed evenly and uniformly to the basket or salt pot in the heating chamber by a MAHR high temperature fan.

This unit is built for air drawing at 1250° F. or other heat treating of either ferrous or light metals at lower temperatures. Made in nine standard sizes. The smaller sizes can easily be used on the floor, and the larger sizes may be pit-sunk for easier access.

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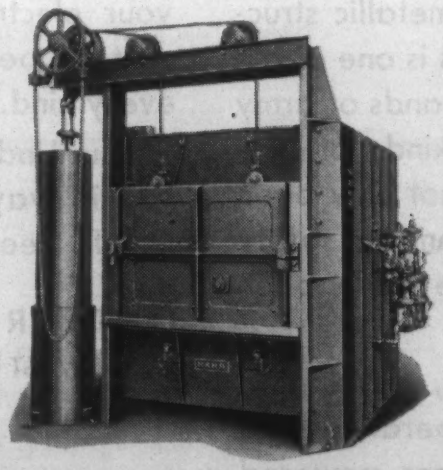

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ing, low surface and corrosion sensitivity under fatigue stress.

High heat conductivity is of no advantage as regards crack formation; on the contrary, low heat conductivity is useful for obtaining a high average temperature. The life of a die-casting mold can be considerably lengthened by taking these points into account, but complete suppression of cracks will be possible only after the present insufficient knowledge has been improved by further investigations.

—E. Mickel. *Z. Ver. deut. Ing.*, Vol. 87, June 12, 1943, pp. 341-345.

Silver Brazed Joints

Condensed from "Steel Processing"

To produce silver-brazed joints that are sound, ductile and strong, it is necessary to have a good fit and clean metal and use proper procedure in fluxing, assembling, heating and cleaning the joint.

Butt, scarf, and lap or shear joints are the principal types used in silver brazing. Each can be used with flat or tubular members. The butt or scarf joint is used where a double thickness of metal is objectionable. The scarf joint is a modified butt joint that permits a greater area of joint for the same thickness of metal.

Lap joints provide a bonding area that can be varied to meet specific requirements, permit a greater factor of safety against breakage and leakage, and can be assembled easily. A light pressure applied during the heating of a joint often aids in producing an excellent bond, and this is possible with many types of lap joints.

Joint clearance should be 0.001 to 0.004 in. to insure a thin film of brazing alloy. Capillary action causes the molten alloy to flow throughout the joint area. It is objectionable to have large fillets, as they do not add materially to the strength of the joint and certainly not in proportion to the cost.

Parts to be brazed must be cleaned thoroughly either chemically or mechanically, the latter being often the most convenient and satisfactory. A satisfactory flux for low-temperature silver brazing is a paste of potassium fluoride and other salts in water. It may be applied by brushing on all surfaces where the alloy should flow.

For high-speed, large-quantity production, use of preplaced rings and inserts of brazing alloy is gaining. Gas-air, acetylene-air, oxygen-gas, oxyacetylene, and other methods of torch brazing have all been used successfully. The oxyacetylene torch is most widely favored for rapid heat and good control. It is preferable to use a slightly reducing flame, and this is possible with oxyacetylene.

Other successful means of heating are gas and electric furnaces, salt-baths, and electric-resistance brazing. Induction heating is gaining rapidly. Heating can be localized by proper design of the induction coil, temperature control is excellent, and joints can be made in a few seconds.

It is possible with low-temperature brazing and rapid induction heating to make brazed joints in certain heat-treated steel without materially affecting the heat-treated properties of the steel.

—A. M. Setapen. *Steel Processing*, Vol. 30, Sept. 1944, pp. 568-573.

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in 2/3 of a SECOND

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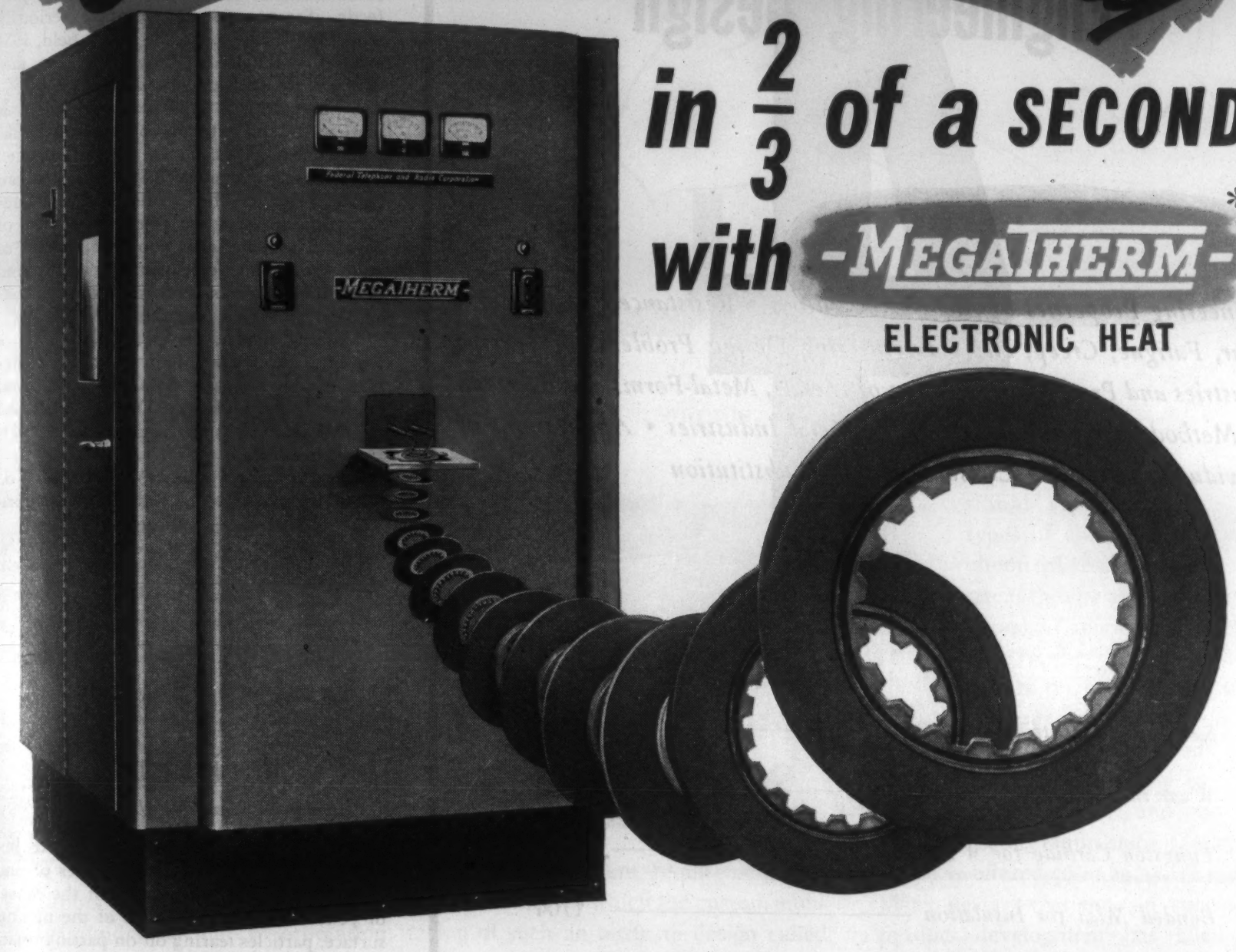

Here's another difficult hardening job, done simply and quickly with Megatherm.

Exact contour hardening of the inner gear of these supercharger clutch discs was done in less than ⅔ of a second each.

These gears were hardened to a depth of .050", with the hardening closely following the tooth and root contour of the gear surface, without affecting the strength or ductility of the remaining metal. The unretouched photograph above tells the story.

To do this contour hardening a jig was built to support the disc so that its inner surface surrounded a two-turn induction coil, directly connected to the output terminals of the 25 kw Megatherm.

The Megatherm automatic timer limits the heat period to exactly ⅔ of a second, then operates a solenoid which trips the disc into an oil-quench bath.

Here is another example of Megatherm's adaptability to many hardening problems involving irregular and "hard-to-get-at" surfaces.

If you have a surface hardening problem . . . whether for wartime or peacetime application . . . consult Federal's Megatherm engineers for the answer or write for complete data.

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4 Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Saran for Industrial Uses ——— 1698

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Bonded Mica for Insulation ——— 1704

Saran for Industrial Uses

Condensed from "Modern Industry"

"Saran" is the name for a family of cheap, easy-to-fabricate plastics enjoying phenomenal development during the war. Now costing less than 60¢ per lb., post-war mass production may allow it to compete with polystyrene, now the cheapest plastic, selling at 15 to 20¢.

Saran is derived from the chlorine of brine and ethylene of petroleum. Arrangement of these molecules (polymerization) can be varied to produce resins ranging from a flexible, moderately soluble material to a hard, tough thermoplastic.

It can be made into black pipe and flexible tubing, into rope, window screen, fish leaders, subway seat coverings, draperies, luggage, and a host of other things. Among its disadvantages are that it cannot stand up under extremes of heat and cold (170 F. is the limit on heat) and has an unpleasant odor where food applications are involved, though the latter bid fair to be remedied.

If it can be given sheerness and softness —and these are possible—it will rival Nylon for hosiery and lingerie. Most important of Saran's qualities is chemical resistance. Neither acids, alkalies salt solutions, organic solvents, or water affect it, nor do bacteria and fungi attack it. It is extremely workable. Pieces can be heated, melted and joined together (weldability), with welds as strong as other portions. It is non-inflammable, tough and durable. As to resistance to flexing, a thin sliver was bent 250,000 times over a ¼-in. rod without a sign of failure.

The box-woven plastic fabric is flexible, durable, resistant to stain, and nonporous. It is available in every color and hue of the spectrum. Dirt is confined to the surface, with cleaning easy with soap and water. In tropical climates screening, tents, soles of Saran filaments for G.I. shoes stand up perfectly. Saran rope may compete seriously with Manila hemp. In the sports field, it is adapted to tennis and ping pong nets, and laces for footballs and basketballs.

Saran tubing is at work where there is hard water and extreme corrosion and caking of metal pipes. Saran pipe is extruded to match the diameters of steel pipe. It can be welded in less than a minute, and fittings to match all sizes are injection-molded of Saran. The material is good for handles of paint spray guns, for closures of bottles and other solvent containers, for pump pistons and gaskets exposed to chemicals.

Masking fixtures in electroplating work are of Saran. The Medical Corps carries vials of the material. Saran films are well known to the Ordnance Dept., being used for packaging guns and equipment for overseas shipment.

Saran is made by the Dow Chemical Co., with Firestone Tire & Rubber Co. experimenting with new applications.

—*Modern Industry*, Vol. 8, Aug. 15, 1944, pp. 38-41.

Wear in Machines

Condensed from "Machine Design"

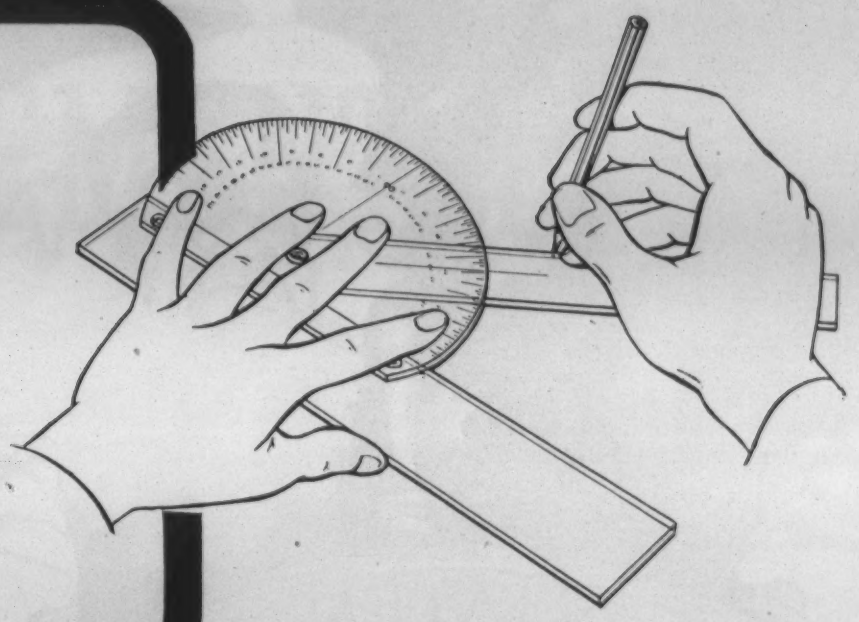
There are two chief types of wear between metal surfaces: The asperities of one surface catch on the asperities of the other, or penetrate into the hollows of the mating surface, particles tearing off on parting; mating metals come into molecular contact, creating incipient welding or galling, with particles of one adhering to the other when torn apart. The chief criterion for wear resistance is hardness. In some instances cold working, melting temperature and thermal conductivity are factors that index wear.

Sometimes surface melting or fusion occurs. A phonograph needle against a wax record may reach 2000 F., though with depth of temperature of a few molecules only. Up to 400 F. temperature does not materially affect wear of ferrous alloys, though it does affect the oil lubricant, thinning it, oxidizing wearing surfaces and possibly tempering hard materials. If surfaces are extremely hard, the chances of seizing and galling are reduced.

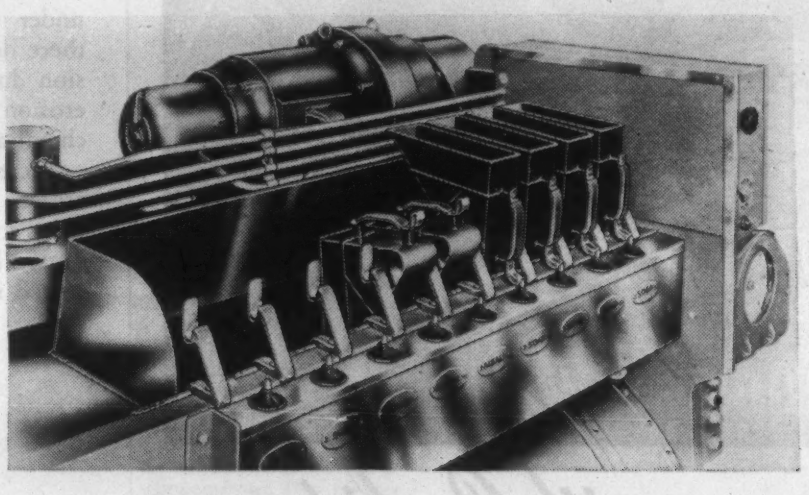
When extreme pressure lubricants are added to the oil, loads at least ten times greater can be carried by steel surfaces without scoring. Such addition agents are carried in auto differentials because of high pressure. Theoretically, mated materials of lead and steel should not gall. However, if the lower melting material "wets" the other, welding may still occur.

Introduction of a third material may be effective, such as graphite. To overcome

DESIGN DATA ON PLASTICS



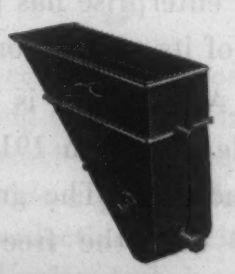
X. Meeting Unusual Chemical Resistance Requirements



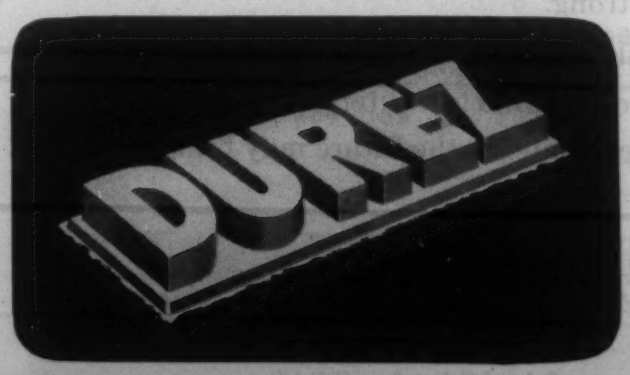
Among the many unusual materials problems confronting the design engineer of today is the particularly tough one of meeting requirements for chemical resistance.

As an excellent example of the solution of just this type problem, the successful development of triangular supply containers for the Robot Washer should prove of unusual interest to the design engineer. The Robot Washer, produced by the Robot Laundry Machinery Corporation, employs an entirely new principle in washing efficiency, using pre-mixed solutions that give uniform performance with no waste of water and supplies. Vital to the perfect performance of this washer are the plastic triangular supply containers (custom molded by the Plastic & Die Cast Products Corporation).

The selection of a plastic material for these containers presented a two-fold problem. First came the question of choosing a material that was resistant to the strong soaps, alkalies, and bleaches which the finished product would be called upon to hold. Secondly, were the stringent requirements for moldability for which the custom molding of such an intricate design called. Here was a genuine need for an unusually versatile plastic . . . to fit a specific job. *A Durez 75 type molding compound fulfilled that need perfectly.*

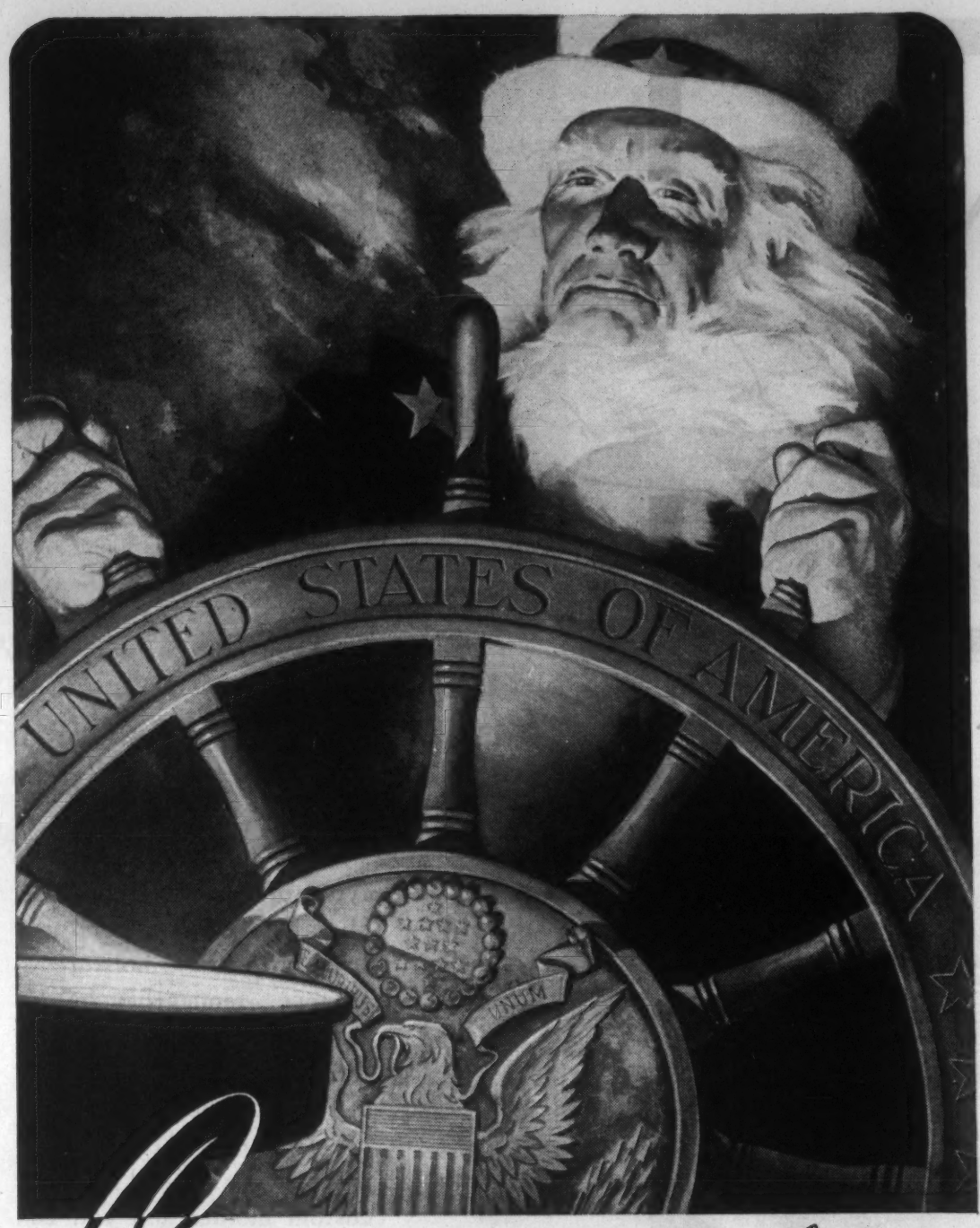


The versatility of the more than 300 Durez phenolic molding compounds has made their use practically universal throughout industry. Such properties as highest dimensional stability under all types of climatic conditions, chemical resistance, impact strength, heat and moisture resistance . . . render them invaluable to the design engineer. Add to the product versatility of Durez compounds the many new molding methods and processes developed by your custom molder, and you can readily appreciate the scope which is offered to imaginative minds. Many years experience in successful product development has filled the Durez files with a wealth of valuable data. These data, plus the full cooperation of experienced Durez technicians, are available at all times towards the successful solution of any materials problem which you may have. Durez Plastics & Chemicals, Inc., 912 Walck Road, North Tonawanda, N. Y.



PHENOLIC MOLDING COMPOUNDS AND RESINS

PLASTICS THAT FIT THE JOB



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FOR the second time in one generation this country is turning the tide of victory in a great war. Abroad, our armed forces have shown what free men can accomplish. At home, free enterprise has proved itself by the tremendous volume of its production.

Acme Aluminum Alloys, Inc. is itself a product of free enterprise. Little known in 1919, it is now among the leaders of its industry. The growth of companies like Acme is proof that the free enterprise system remains vigorous and strong.

Free men and free enterprise are steering this country through a great crisis. Free men and free enterprise can continue on with confidence, whatever the future may bring.

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galling in cast iron, such as piston rings, chemical treatment is employed, such as Ferrotox, bonderizing and granadizing.

An ideal combination is two high-melting-point metals having reasonably separated melting points, both metals to be immiscible in the molten state and the one with the lower melting point having a high thermal conductivity and good stability at high temperature. Such a pair is steel and silver, used for aircraft engine bearings, especially where the silver is plated with indium.

A form of corrosion-wear, due to internal friction activated by vibration, is called fretting, usually found under a press-fitted part where high stresses exist, sometimes occuring where there is no visible motion. But the actual small play makes galling and tearing of tiny particles, which oxidize. Oil does not prevent such corrosion. A cure is often a metal like silver, electroplated on the surface.

Chemical effects often enter in, induced by the temperature rise of the part due to the friction resulting from its motion. Tests show that carbon dioxide greatly accelerates such wear. Much study had been given to cylinder and piston wear. The greatest wear occurs at the top end of the piston travel under the topmost ring, decreasing from there down. There are three reasons: abrasion due to foreign matter in the oil film, erosion due to metal-to-metal contact, and chemical action from combustion.

Increasing hardness of cylinder walls increases wear resistance. Work hardening helps to decrease wear. Pitting is sometimes caused by drops of oil under pressure being forced into tiny surface cracks.

—D. Landau. *Machine Design*, Vol. 16, Sept. 1944, pp. 105-108.

Tungsten Carbide for Wire Dies

Condensed from "Wire and Wire Products"

When tungsten carbide dies were first imported into the United States, a set was quoted at $1,200. At that time the only use for it was in wire drawing.

The material that marked the commercial beginning of tungsten carbide was made by Krupp and known as Widia. Several sets of dies made from this material were brought from Germany and tried in a copper mill. They were installed on a rod machine that finished at 0.080 in. and about 40,000 lb. of one size were obtained from one set of dies. Further tests with shape, speed and lubricants resulted in the production of 125,000 to 150,000 lb. of perfect wire.

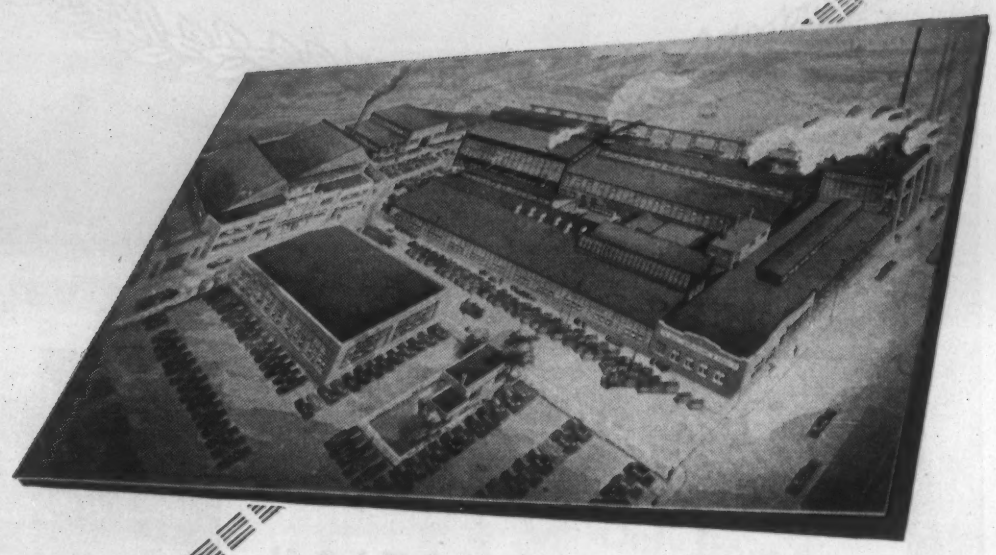
The wire produced was absolutely round, and on size, with a mirror finish, as compared with the product produced in a chilled-iron die. Wire on these intermediate machines is currently being run off at 5 to 6000 ft. per min. and as high as 10,000 ft. per min.

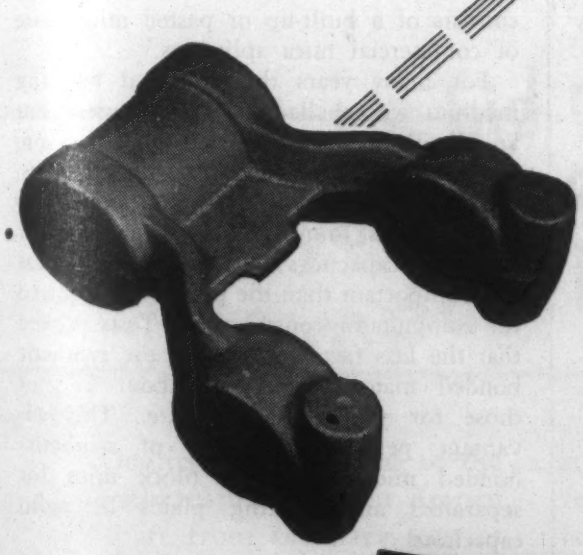
By means of trial and error, and from

(Continued on page 1704)

One purpose ...

the IMPROVEMENT of Metals

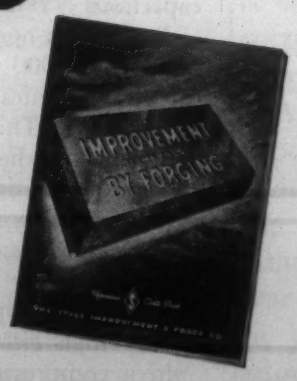




Continuous fibre flow throughout the structure of this unit is essential to provide the physical properties necessary to meet exacting service requirements.

by Forging

Forgings are frequently specified in response to an irrepressible urge to improve an operating mechanism. In forgings metal quality can be developed in the exact degree required to assure dependable performance and provide a greater factor of safety. Throughout 31 years of forging production experience our engineers have employed all the known forging techniques to obtain the utmost metal quality inherent in specific metals and to forge many so-called impossible-to-forge designs. Ask one of our forging engineers to show you how the IMPROVEMENT OF METALS BY FORGING can keep you ahead of competition in peacetime.



Reference Data Booklet presents many new ideas on forgings and their applications in many different kinds of equipment. Copies available to engineers, metallurgists and executives.

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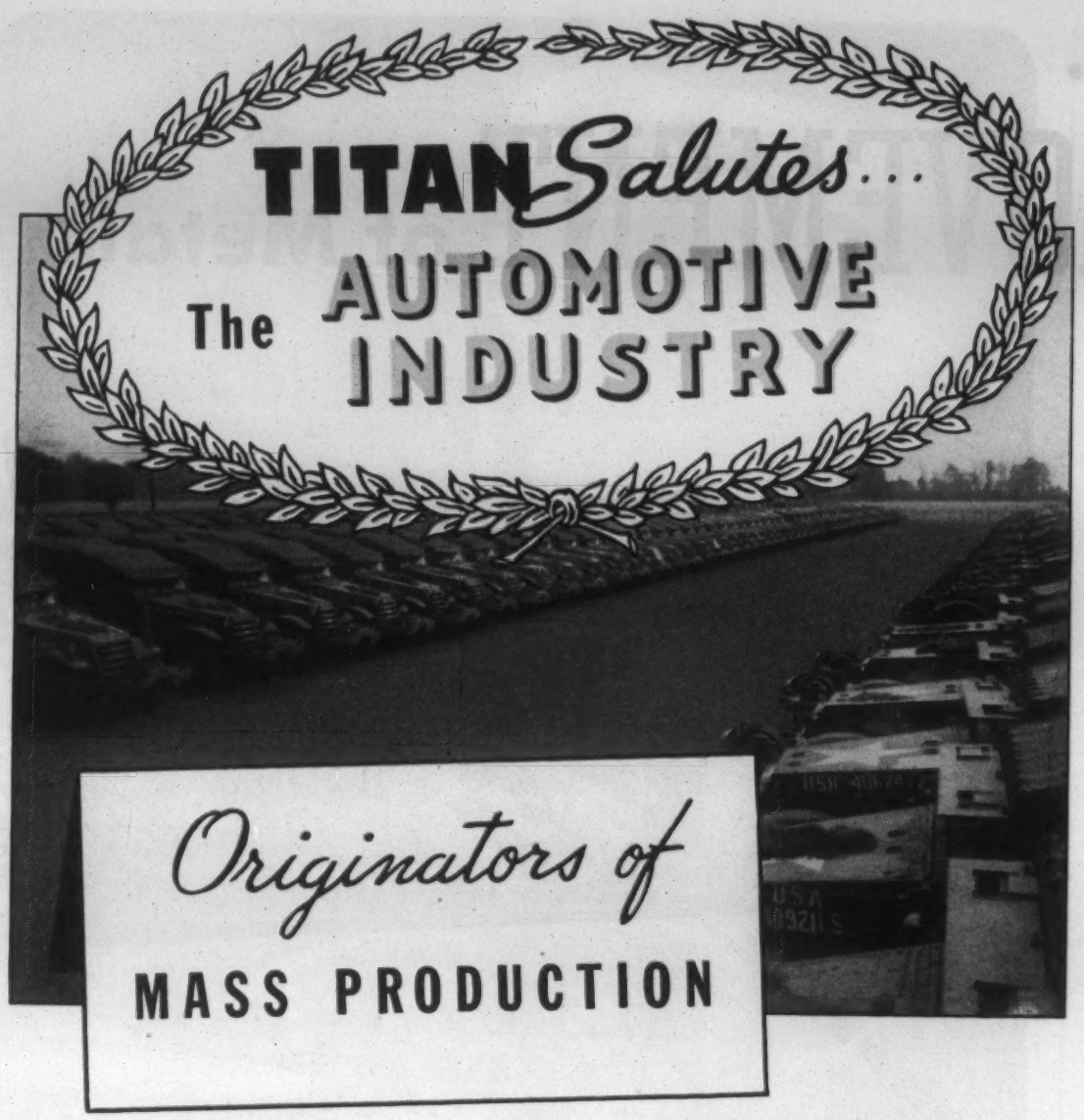

★ TITAN salutes the industry that put the world on wheels. The automotive industry turns out thousands of vehicles a month in peace-time—an industry that now produces an incredible number of planes, tanks, jeeps and trucks with those magic words, "mass production."

War brought a stupendous demand for military machines. The automobile industry converted assembly lines and production systems and used these procedures to manufacture that vitally needed equipment.

Mass production, originated and perfected by this industry, is undoubtedly one of the strongest weapons we possess in our war of supply.

TITAN supplies these assembly lines with hot pressed brass parts of various and intricate shapes, many faultlessly machined for immediate insertion in these machines of war. Call on us after this war is won. We can then supply *you* with superior hot pressed parts.

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information obtained from various mills, formulae were derived for the proper shaping of dies. It was found that even the best material, with improper entrance angle or length of bearing, shortened the life of the die.

Research done in recent years leads to the conclusion that a great deal of trouble encountered is not caused in the finishing end but rather is due to the practice of disregarding the shapes employed in ripper dies.

In order to bring the initial installation price of carbide within a more economical range, rough-drilled dies were first tried. These were followed by the rough-cored die, which is the form in which most of the dies are now furnished.

Carbide dies were adopted for the following reasons: (1) Wire is held to closer tolerances. This opened a wider field for wire and led to closer specification; (2) high production; (3) better finish; (4) elimination of scrap; (5) many types of wires can be made economically; and (6) highly skilled help is not required.

—A. R. Zapp. *Wire & Wire Products*, Vol. 19, Sept. 1944, pp. 543-546, 569-571.

Bonded Mica for Insulation

Condensed from "General Electric Review"

Mica has always occupied a high place among dielectric materials, but any method of fabrication that destroys the laminated structure also destroys the dielectric value. Normally, most mica electrical insulation consists of a built-up or pasted mica plate of commercial mica splittings.

For many years the preferred bonding medium was shellac. It is still used, but an alkyd-resin solution that gives definite advantage is used in increasing amounts. As war increased the demand for built-up mica, it was found that (particularly for electronic capacitors) the power factor was more important than the properties required for commutator construction. Tests proved that the loss factor values for the synthetic bonded material averaged about 1/5 of those for shellac-bonded plate. This advantage permitted the use of synthetic-bonded mica instead of block mica for separators and backing plates in radio capacitors.

Recently, a new type of synthetic resinous bond, No. 7000 Resin, has been developed for built-up mica insulation in its principal applications. This has greater stability under combined heat and pressure.

Tests of built-up mica plate produced with various bonds proved that the No. 7000 Resin possessed arc resistance equivalent or slightly superior to shellac-bonded mica. It also slipped less and seasoned more rapidly than either shellac or alkyd bond.

In a compressive and slippage temperature-cycle test of built-up mica, a synthetic-resin-bonded mica tape, designed for this type of application, withstood more than 25 times as many cycles as natural resin-bonded mica.

—L. E. Barringer & K. N. Mathes. *Gen. Electric Rev.*, Vol. 47, Oct. 1944, pp. 15-19.

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5 Testing, Inspection and Control

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Recent Inspection Developments

Condensed from "Engineering Inspection"

Because of the labor shortage, the tendency has been to increase applications of well-known instruments rather than invent novel forms of inspection apparatus. Another tendency has been to standardize and simplify so that unskilled labor can do inspection work. There have been many new applications of X-rays, crack detectors, non-destructive tests, automatic gaging devices, etc., suitable for the amateur.

Electro-magnetic appliances for detecting cracks in steel parts have increased their scope, particularly for tubular structures, useful in aircraft assemblies. The testing of non-magnetic materials has expanded by measuring the changes in eddy current patterns.

There has been a surge in the use of fluorescent liquids, entrapped in defects. Direct measurement of magnetic permeability is useful in determining corrosion-resistance of stainless steels.

A protractor which incorporates a lens has been developed to facilitate rapid reading of angles. A toolmakers' microscope has been adapted to measure work without removal from the machine. Often bells ring to indicate certain conditions, thus relieving concentration.

Electronics sometimes reject defective items. The measurement of bores has been refined by a gage with an amplifying attachment, with 0.001-in. readings.

A remarkable innovation are gages of lime or borosilicate glass, having hardness, abrasion-resistance, and not burring or rusting. The advisability of correct lighting conditions for inspection is appreciated in Britain and the United States.

Multiple inspection is often used, involving a multiple setting for checking gears for run-out of pitch diameter, size of bore, concentricity, incorrect teeth and excessive burrs.

There is stricter inspectional supervision of incoming raw materials. Aluminum alloys have brought forth a search for the best hardness testing machines, and a specification has been issued to standardize tensile and hardness-testing conditions applicable to light alloys. A special straining apparatus detects cracks in axles.

Recent testing equipment has been devised to enable routine methods of surface examinations. A projection microscope measures surface roughness, with photographic records, if necessary. A recent shear-hardness attachment computes surface toughness by comparing measurements of a groove cut into the metal. Comparisons of light reflections indicate flatness and finish of surfaces.

The foundry and welding shop have adopted radiology, the use of radium increasing in the United States. Heavy bronze and steel castings are now measured by million volt X-rays. Combinations of X-rays and fluorescent screens have taken hold for large batches of work. Radiological examination of welds has become common.

The quality of radiographs and micro-radiographs has been improved by new films, cassettes and exposure meters for X-rays. The application of crystallography to routine analysis is recent. Inspection of bearings has become a specialized field.

—H. H. Jackson. *Engineering Inspection*, Vol. 9, Summer 1944, pp. 30-32.

X-Ray Inspection of Light Metals

Condensed from "Western Metals"

There are two types of X-ray radiation: (1) Primary focal radiation, which is required for the formation of the image on the film; and (2) secondary or stray radiation, which forms a fog on the film and thus reduces the legibility of the image and the proper delineation of the cavities.

The stray radiation, obviously undesirable, may emanate from: (1) The portion of the X-ray tube outside the focus area, usually caused by poor electrode design; (2) filters placed in the path of the radiation beam; (3) objects adjacent to the casting being radiographed; (4) the casting itself; or (5) the supports on which the casting is placed for inspection.

The presence of the first type of stray radiation may be determined by exposing a film through a pinhole (1.5 to 2 mm. in diam.) in a lead sheet (generally ⅛-in. thick) placed between the X-ray tube and the film. Only the image of the target should be revealed on the exposed film.

To avoid the second type of stray radiation, any metallic filters used to alter the quality of the X-ray beam should be carefully chosen to eliminate this source of

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The Causes of Failure

Shrinkage cracks in 2 cast aluminum motor housings.

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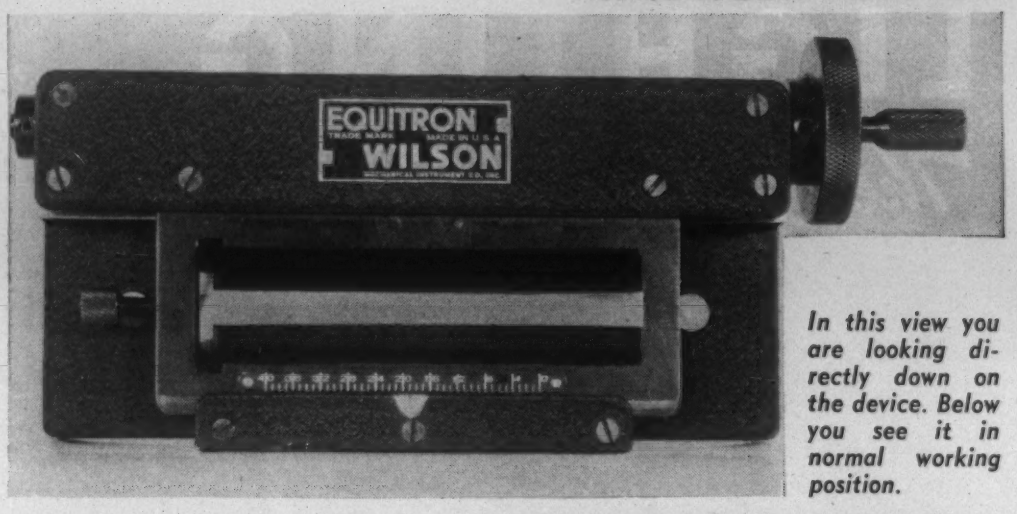
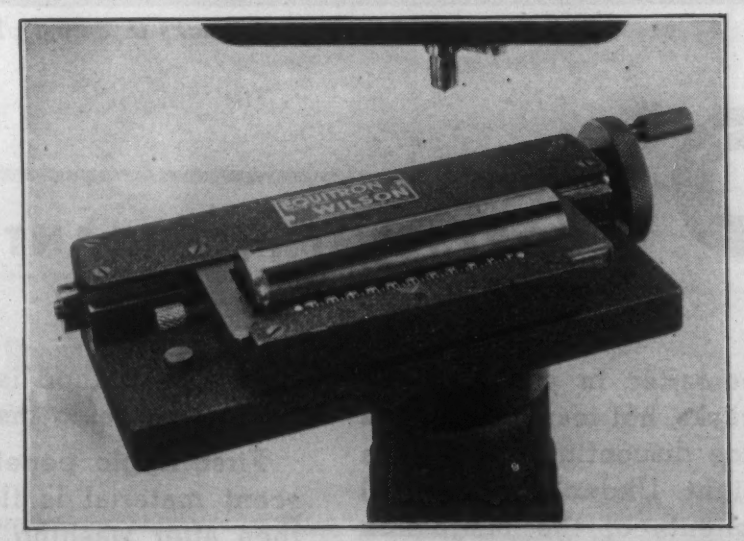


In this view you are looking directly down on the device. Below you see it in normal working position.

The "EQUITRON" fixture is recommended for properly supporting the preferred specimen for the end quench test for hardenability of steel (generally referred to as the Jominy End Quench Test). This fixture is designed to properly support the specimen and also to provide means for accurately positioning the sample for each successive "ROCKWELL" hardness test at 1/16" intervals. The fixture is quickly and easily clamped securely to the elevating screw by means of a nut, which has proven decidedly preferable to reliance upon a stalk fitting into the hole in top of the elevating screw of the tester. Ground surfaces are provided to support the underneath surface of the specimen. The specimen is thus supported so that it does not rock or tip as the tests are made, notwithstanding the required moving of the specimen.

Accurate spacing of the indentation is accomplished by a wheel and handle located at one end of the fixture. One revolution of the wheel provides a motion of the specimen of 1/16 of an inch. A ball click indexing mechanism indicates each 1/16" spacing, so one need pay little attention to the scale markings. The specimen is securely held in positive indexed position by spring pressure. This jig permits tests to be made up to 2½ inches from the quenched end of the specimen, and a scale is provided to indicate the positions at which the test is being made and to facilitate tests at greater intervals than 1/16" if it is desired.



EQUITRON in position in "ROCKWELL" Tester

The screw for moving the specimen operates in oilless bearings. This fixture can be used on all "ROCKWELL" Hardness Testers of 8" vertical capacity (size 3), or taller.

No attempt is made here to discuss the purposes and technique of carrying out end quench tests, as those are given at length in recommendations published by several technical societies.

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scattered radiation. Beryllium windows on the tube are preferable.

In light metal castings of complicated design, fillets, bosses and thin shells serve to overlap and spoil the effective sensitivity. Where the change in section varies considerably, steps must be taken to reduce the stray radiation from this cause. The best expedient is to use a lead foil (0.003 to 0.005 in. thick), interposed between the tube and the front surface of the film and in contact with the film. Due to its absorption characteristics, which are different from the light metal castings being inspected, this foil intensifies the primary focal radiation more strongly than the stray radiation and absorbs the latter more effectively. As a result, the sensitivity is increased, but at the cost of an increased exposure time.

The proper material on which to place the film is of great importance. Bakelite and wood should never be used as materials on which to position the castings. Lead is most efficient as it scatters little if any radiation back to the film. To determine if back-scattered radiation is present, a film should be exposed with an ⅛-in. thick lead sheet between the tube and the film, and another film without the lead sheet.

Densitometer readings taken over the whole surface of the film will show if any fogging is present. If a densitometer is not available, the films may be matched in a high intensity illuminator.

The scatter from thin sections of castings undercut into thicker sections may become so intense as to completely mask out cavities; therefore, it is essential to use every available means to reduce stray radiations.

—R. Taylor. *Western Metals*, Vol. 2, Sept. 1944, pp. 25-26; 29-30.

Aluminum and the Hardenability of Steel

Condensed from "Archiv Eisenhüttenwesen"

The determination of the tendency to transformation in the austenite-pearlite stage has proved to be a good means in the routine testing of melts of alloy steels for hardenability. This is done by quenching small plate specimens from hardening temperature in a metal bath, which is kept at the temperature of the greatest transformation velocity, holding it there for a definite time and then quenching in water and determining the hardness.

The determination of the most favorable metal bath temperature and holding time in the bath is illustrated by melts of steels with 0.2 to 0.4 C, 1 Cr and 0.15 to 0.35% Mo, and with 0.25 C, 1.1 Mn, 1 Cr and 0.2% V. The amount of aluminum addition for deoxidation has a predominating effect on hardenability over carbon, silicon, manganese, chromium and molybdenum content.

In order to obtain a very uniform through-refining, the addition of aluminum should not exceed 0.1 kg. per ton for steels melted in the basic arc furnace.

—H. Krainer. *Arch. Eisenhüttenw.*, Vol. 17, July/Aug. 1943, pp. 11-16.

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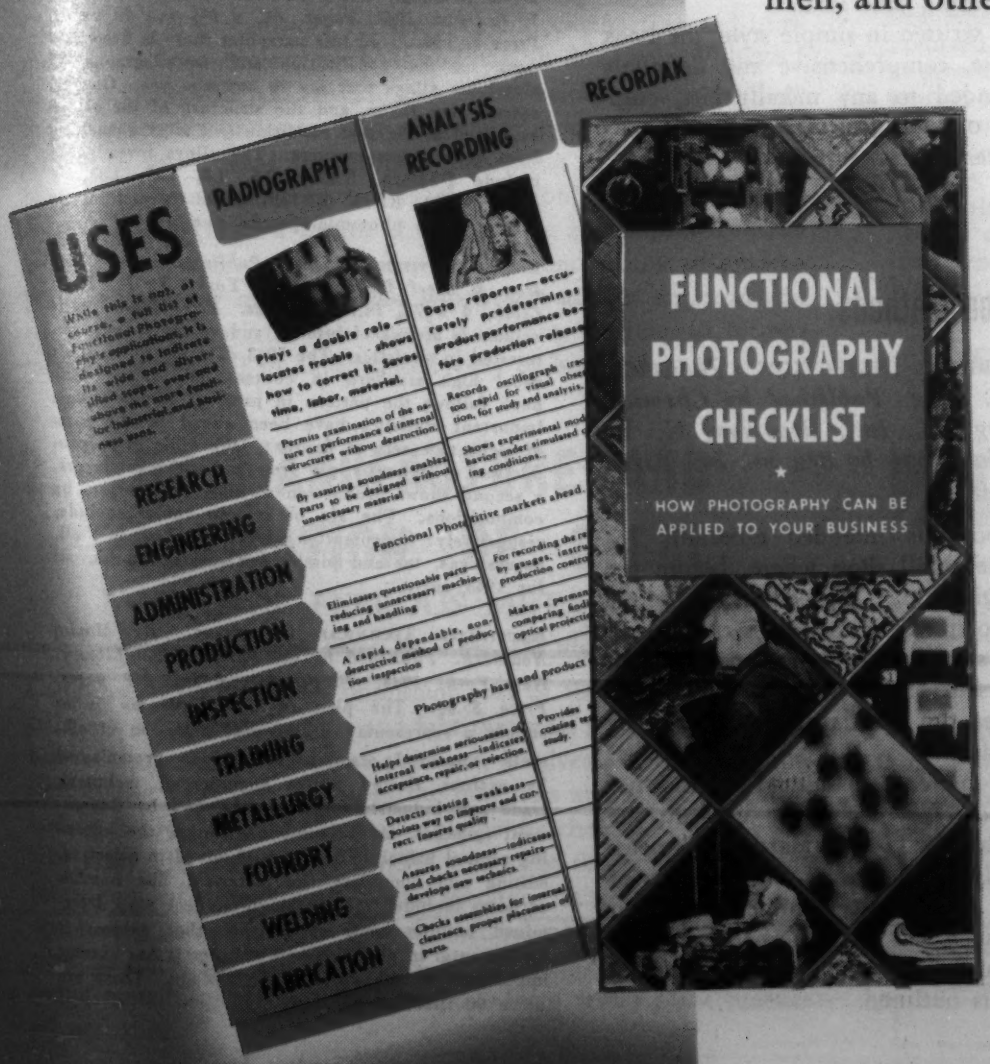
Yes, in industry, at many important, specialized jobs, photography is proving its worth; and the scope of its applications is increasing rapidly, well beyond its general use in illustration, recording, copying, and other familiar operations. In fact, the usefulness of functional photography is limited only by the ingenuity with which metallurgists, engineers, foundrymen, and others apply it to their individual purposes.



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books

FOR METALLURGICAL ENGINEERS

Extruding Metals

THE EXTRUSION OF METALS. *By Claude E. Pearson. Published by John Wiley & Sons, Inc., New York, 1944. Cloth, 5¾ x 8¾ in., 205 pages. Price $3.75.*

An enormous amount of investigational work has been carried out in many places in the general field of extrusion of metals. As a result, there are a large number of articles in the literature covering many particular aspects of the broad field. However, up until now there has been no single comprehensive work covering practically all of these phases. Mr. Pearson's new book does cover the field quite completely.

The historical survey at the start of the book, although brief, is adequate and is more interestingly presented than many similar chapters in other technical works.

Two chapters are devoted to extrusion of lead and other soft metals, including the production of cable sheathing. In the latter connection the author goes into much detail about the design and operation of the many different presses that have been and are currently used. Many excellent illustrations, both photographs and drawings, give a thorough insight into the relations between press design and operation on the one hand and size, type and quality of the product on the other. The alloys used are covered from the standpoint of properties, but the metallurgical and metallographical aspects are not featured.

The equipment, tools and operating characteristics of presses for hard and relatively higher melting point alloys are equally well and thoroughly treated in a subsequent chapter. Separately much space is devoted to the flow of metals in extrusion and to the related features of pressures, structure and properties of the product. These latter aspects are particularly well covered, the author having condensed a surprising amount of detail into a few chapters.

Finally, impact extrusion and certain special operations combining the features of extrusion and of forging are described. Thus, in a literal sense the whole field is covered.

There seems to be a pattern followed by book reviewers wherein they first speak of the commendable features. Then, as if by tacit agreement, they proceed to call attention to a few more or less serious shortcomings. A departure from the sequence is of necessity here made, since the present reviewer could find no important omission nor any statements with which he seriously could take issue.

While written in simple style, the book is accurate, comprehensive and definitely recommended to any metallurgist, engineer and operating supervisor having any real interest in the subject.

—D. K. CRAMPTON

Inspection Methods

ENGINEERING INSPECTION PRACTICE. *By A. T. King. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1944. Cloth, 5¾ by 8¾ in., 242 pages. Price $3.00.*

This book is intended especially for use in the small shop where, before the war, engineering inspection technique was unknown in the modern sense. Many of these small shops have become subcontractors to large manufacturers, and must meet the standards established by these leaders.

Subject-matter is confined to the use of the tools that would be used in the smaller shops. The standard hand-measuring tools are described, and the use of some of the more elaborate inspection devices, such as the comparator, gear testing instruments, and the measuring machine, is outlined.

English equipment is quite similar to the standard American inspection devices, but the American reader will look in vain for familiar trade names. Several omissions may be excused on the same grounds, possibly, as for instance the description of optical flats but failure to mention the optical micrometer with which they are commonly associated. The electric gages so common in American practice are referred to as tool checking instruments. A pneumatic micrometer is described, but there is nothing to correspond to the air gage in use in this country.

An introduction to blueprint reading is given, and a section upon mechanical testing and engineering materials in general provides an introduction to those fields.

—KENNETH ROSE

Other New Books

THE SUPERVISOR'S JOB IN INDUSTRY. *By Anthony C. Baudek and Mark L. Brooks. Published by McKnight & McKnight, Bloomington, Ill., 1944. Paper, 4½ x 6 in., 128 pages. Price 80c.* A guide in outline form, this handy book was prepared to help the supervisor in solving his problems. The four main sections are: The Supervisor's Place in Industry; Maintaining a Working Staff; Getting Out Production; and Employer-Employee Relations. Profusely illustrated with cartoon-type drawings.

BIBLIOGRAPHY OF SOLID ADSORBENTS. *By Victor R. Deitz. Published by the U. S. Cane Sugar Refiners & Bone Char Manufacturers and the National Bureau of Standards, Washington, D. C., 1944. Cloth 7¼ x 10¼ in., 877 pages. Price $12.00.* Largely organic chemistry, with only a few brief sections (about 50 pages) relating to the absorption of gasses in metals. Orders for this book should be sent to Dr. J. M. Brown, Revere Sugar Refinery, 333 Medford St., Charlestown 29, Mass.

METALLOGRAPHY OF SOME ALUMINUM ALLOYS. *By M. D. Smith. Published by British Non-Ferrous Metal Research Assn., Euston St., London, N. W. I, England, 1943. Paper, 6¼ x 9¾ in., 20 pages. Price 2s (50c).* In this pamphlet there is described work on the constitution and metallography of aluminum alloys that are in common use. Cooling curves were taken, and the structure of the alloys examined in the cast condition and after quenching from various temperatures. The alloys investigated include DTD424, NA226, L5, L8, L11, L33, Y alloy, RR50, RR53, RR72B, Aeral A and Alpax gamma. The photomicrographs number 28.

ANNUAL STATISTICAL REPORT. *Published by American Iron & Steel Institute, New York, N. Y., 1943. Cloth, 6 x 9¼ in., 118 pages. Price $5.00.* This volume is always of interest and value to those interested in statistics. The 1943 data are up to their usual high standard in content and value. The book follows the pattern in previous issues. Some important statistics have been added in the form of eight new sets of figures: One table gives production of coke by pig iron and steel producers, a second shows production of alloy steel ingots by compositions. The six other new tables include, respectively: Consumption of coal; fluxes; fuel oil, natural gas, tar and pitch; and electric power, all for 1943 only.

ILLUSTRATED TECHNICAL DICTIONARY. *By Maxim Newmark. Published by the Philosophical Library, New York, 1944. Cloth, 6 x 9 in., 352 pages. Price $5.00.* The plan of this dictionary is to supply a representative and wide selection of officially approved standard definitions promulgated by various United States engineering, technical, trade and industrial organizations, and by Government agencies. As to subject coverage, the following general principle has been observed in selecting, editing and compiling the material: The number of terms included for any single subject were determined on the basis of whether that subject is fundamental in all fields and whether it has current importance in the world of technology. There are some 90 illustrations.

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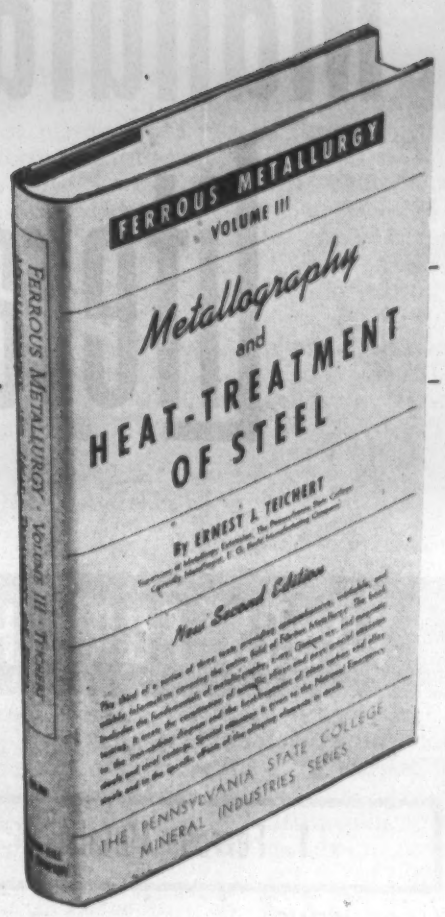

These three books, including the latest and most complete information on equipment and practice, give an extensive, factual course in ferrous metallurgy, theory and practice. Based on material used by the Pennsylvania State College in its extension classes in Metallurgy for the past 10 years and in Engineering, Science, and Management War Training courses during the past two years, these books will prove important and complete reference works for practicing metallurgists and engineers and will help every iron- and steelworker to grasp more readily the technical aspects of his job.

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Metal Forging. Steel Improvement & Forge Co. (3-409)

METAL PARTS

Precision Bearings. Miniature Precision Bearings. Bulletin No. 44, four pages, describes and illustrates a complete line of miniature ball bearings for precision industrial equipment. Specifications are included. (3-504)

Manganese Steel for Cement Mill Equipment. American Manganese Steel Div., Am. Brake Shoe Co. (3-386)

Thermostatic Bi-Metal. Callite Tungsten Corp. (3-427)

Electrical Contacts. Gibson Electric Co. (3-76)

Magnet Manufacture. Indiana Steel Products Co. (3-359)

Bronze Bearings. Johnson Bronze Co. (3-224)

Sheet Metal Parts. Kirk & Blum Mfg. Co. (3-238)

Bellows, Detectors, Etc. Metal Fusion Corp. of America, Div. Cook Electric Co. (3-486)

Covers for Ball and Roller Bearings. R-S Products Corp. (3-192)

NON-METALLICS

Plastics. Chemaco Corp. Complete data on Chemaco Polystyrene, a thermoplastic resin for injection and extrusion molding, are presented in a 4-page bulletin. (3-502)

Resistant Glass. Corning Glass Works, Industrial Div. Complete data on the properties of Pyrex resistant glass No. 774 are presented in an 8-page bulletin, No. 844. (3-495)

Plastics. E. I. duPont de Nemour & Co., Inc. Five types of plastics, and their general properties, characteristics and applications, are described in an illustrated, 8-page bulletin. (3-500)

Injection Molding Machine for Plastics. Lester-Phoenix, Inc. The Lester injection molding machine that produces better moldings at higher speed and lower cost is described and illustrated in a 4-page, pocket-size booklet. (3-505)

Laminated Plastic. National Vulcanized Fibre Co. Technical data on Phenolite, laminated Bakelite, are presented in a well-illustrated, 44-page booklet. Navy and Federal specifications are included. (3-494)

Liquid Plastic. U. S. Stoneware Co. Tygon Tempro-tec, a liquid plastic that is applied to metal by spray gun or brush, dries quickly, easily removed, and resists all plating solutions, is described and illustrated in a single sheet. (3-503)

Plastic Laminate. Continental Can Co. (3-475)

Plastics. Dow Chemical Co., Plastics Div. (3-484)

Plastics in Product Design. Durez Plastics & Chemicals, Inc. (3-93)

Plastics. General Electric Co. (3-362)

Cellulose Acetate Plastics. Hercules Powder Co. (3-108)

Plastic Custom Molding. Imperial Molded Products Corp. (3-389)

Plastics. Monsanto Chemical Co., Plastics Div. (3-277)

Molded Plastic Products. Plastic Manufacturers, Inc. (3-430)

Plastics. Richardson Co. (3-403)

Ceramic Plastics. Westinghouse Electric & Mfg. Co. (3-236)

POWDER METALLURGY

(See also Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing)

Powder Metal Bearings and Parts. Chrysler Corp., Amplex Div. (3-473)

Powder Metallurgy Parts. Moraine Products Div., General Motors Corp. (3-139)

Powder Metallurgy. Powder Metallurgy Corp., Div. General Bronze Co. (3-441)

TUBING

Steel Tubing Bursting Pressure Chart. Globe Steel Tubes Co. Bulletin No. 112, 24 pages, presents a complete reference chart with tables of bursting pressures of seamless steel tubing from ⅛-in. to 9⅜-in. O.D. Several illustrations are included. (3-493)

Beryllium-Copper Spring Tubing. Summerill Tubing Co. This one-page reprint describes and illustrates spring tubing of beryllium-copper, in round and oval forms, which is particularly suitable for use in the aircraft field. (3-496)

Piping. Flori Pipe Co. (3-345)

Seamless Tubing. Tube Reducing Corp. (3-492)

OTHER METAL FORMS

Woven Wire Screen and Cloth. Newark Wire Cloth Co. Complete data on woven wire screen and wire cloth products, including their application, selection and use, are presented in a 116-page, spiral bound catalog, No. C. (3-507)

Aluminum Extruded Shapes. Reynolds Metals Co. Bulletin No. 35-A, eight pages, presents complete data on aluminum extruded shapes. Diagrams of the extrusion process, specifications, tolerances, etc. are included. (3-506)

Weldments. Graver Tank & Mfg. Co., Inc. (3-425)

Metal Spinnings. Milwaukee Metal Spinning Co. (3-397)

4. Melting • Refining • Casting

ALLOYING AGENTS

Alloys in Foundries. Niagara Falls Smelting & Refining Corp. (4-139)

AUXILIARIES

Core Coating, Binder. Foundry Rubber Compounds Corp. Complete data on Paraspray, a fast-setting, air-drying compound for film-coating the surface of cores or molds, and Paraset, a rubber core binder usable in all metal castings, are presented in a 16-page bulletin. (4-215)

In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.

Plaster Molds. Castings Patent Corp. This 6-page reprint presents an article on the Capaco plaster mold process for producing non-ferrous castings. (4-218)

Centrifugal Casting Methods. Centrifugal Casting Machine Co. (4-203)

Crucible Furnaces. Crucible Manufacturers' Assn. (4-213)

Precision Machines. Reed-Prentice Corp. (4-196)

Core Oil. Smith Oil & Refining Co., Industrial Oils Div. (4-181)

Zirconium and Titanium Products. Titanium Alloy Mfg. Co. (4-125)

REFINING AGENTS

Iron Deoxidizer. Foundry Services, Inc. (4-205)

MELTING FURNACES, MACHINES AND PARTS

Melting Furnaces. Fisher Furnace Co. A complete line of furnaces for melting non-ferrous metals, as well as a variety of blowers, oil burners, etc., is presented in a 12-page, illustrated bulletin, No. 550. Specifications and diagrams are included. (4-217)

Melting Furnaces. W. S. Rockwell Co. Bulletin No. 411, four pages, describes and illustrates both stationary and tilting type crucible melting furnaces, oil- or gas-fired, for aluminum, brass, bronze, copper, nickel, silver and other non-ferrous metals. Specifications are included. (4-216)

Melting Furnaces for Low-Melting Metals. Surface Combustion Div., Gen. Properties Co., Inc. This 4-page bulletin describes and illustrates a variety of furnaces for soft metal melting, and includes a table of properties of soft metals. (4-214)

High Frequency Furnaces. Ajax Electrothermic Corp. (4-60)

Proper Melting in the Foundry. Ajax Metal Co. (4-81)

Metal Melting Furnaces. Campbell-Hausfeld Co. (4-119)

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Recuperative Open Hearth Furnaces. Fitch Recuperator Co. (4-101)
Regenerative Furnace System. Morgan Construction Co. (4-72)
Electric Melting Furnaces. Pittsburgh Lectromelt Furnace Corp. (4-61)
Cupolas. Whiting Corp. (4-131)

5. Heating • Heat Treatment

ATMOSPHERES AND GENERATORS

Atmosphere Furnaces. Lithium Co. Principles and data on Lithium metallic vapor atmosphere furnaces are presented in an illustrated, 20-page bulletin. (5-566)
SO_2 in Magnesium Industry. Ansul Chemical Co. (5-379)
Anhydrous Ammonia. Armour Ammonia Works. (5-435)

AUXILIARIES

Heat Generators. Airtronics Mfg. Co., Div. Aerocrafts Corp. (5-559)
Controlled Quenching. Bell & Gossett Co. (5-561)
Specifications and Heat Treating Chart. Chicago Flexible Shaft Co. (5-264)
Pressed Steel Pots. Eclipse Fuel Engineering Co. (5-352)
Industrial Sub-Zero Machines. Kold-Hold Mfg. Co. (5-390)
Treating Metals at Minus Zero. Motor Products Corp., Deep-Freeze Div. (5-389)
Wire Mesh Baskets. Rolock, Inc. (5-235)
Quenching Oil Cooling Systems. Trane Co. (5-309)

BATHS AND COMPOUNDS

Case Hardening. American Cyanamid & Chemical Corp. (5-459)
Nicarb Case Hardening. American Gas Furnace Co. (5-452)
Liquid Bath Carburizers. G. S. Rogers & Co. (5-492)

BURNERS

Hot Air Burners. Bloom Engineering Co. A 2-page bulletin, No. 1020, describes hot air burners for use with combustion air preheated to 600 to 1500 F. Specifications and diagrams are included. (5-563)
Gas Burners and Combustion Equipment. Burdett Mfg. Co. (5-534)
Gas Appliances. Johnson Gas Appliance Co. (5-286)

ELECTRICAL HARDENING AND HEATING

Induction Heat Treating. Central Boiler & Mfg. Co. The advantages of electronic induction heat treating of metals are cited in a 6-page, illustrated folder. (5-567)
Electric Forging Heaters. American Car & Foundry Co. (5-23)
Induction Heating Data Sheets. Induction Heating Corp. (5-299)
Induction Heating Equipment. Lepel High Frequency Laboratories, Inc. (5-355)
High Frequency Induction. Ohio Crankshaft Co. (5-512)

FURNACES

Immersed Electrode Salt Bath Heat Treating. Dempsey Industrial Furnace Corp. This new booklet, No. 3-7, analyzes and discusses the advantages of immersed electrode salt bath heat treating. (5-565)
High Temperature Sintering Furnaces. Harper Electric Furnace Corp. Bulletin No. 442, two pages, describes and illustrates high temperature electric furnaces for sintering powdered metals. Specifications are included. (5-564)
Electric Furnace. Sentry Co. A size No. 3, Model "Y" electric furnace, designed especially for the quality hardening of fairly large high-speed steel tools, is described in bulletin No. 1022-3, one page. (5-537)
Electric Salt Bath Furnace. Ajax Electric Co., Inc. (5-327)
Furnaces and Furnace Equipment. Amsler-Morton Co., Inc. (5-256)
Heat Treating Furnaces. Drever Co. (5-258)
Electric Furnaces. General Electric Co. (5-469)
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Convection Tempering Furnace. Hevi-Duty Electric Co. (5-538)
Heat Treating and Laboratory Furnaces. K. H. Huppert. (5-303)
Heat Treating Furnaces. Lindberg Engineering Co. (5-369)
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OVENS

Core Baking and Mold Drying Oven. Despatch Oven Co. (5-505)
Ovens for Finishing Processes. J. O. Ross Engineering Corp. (5-273)
Electrically-Heated Ovens. Harold E. Trent Co. (5-521)

PROCESSES

Flow Heat Treatment. A. F. Holden Co. This 4-page, illustrated bulletin, No. 115, describes a flow heat treatment for bright hardening, quenching, tempering, etc. (5-568)
Quenching of Steel. E. F. Houghton & Co. (5-467)
Surface Hardening Stainless Steel. Industrial Steels, Inc. (5-422)
The Nitriding Process. Nitralloy Corp. (5-278)

6. Refractories • Insulation

Linings for Ladles, Etc. Ironton Fire Brick Co. A single-page reprint describes and illustrates "Ironton Caro-Line," a siliceous ramming refractory for ladles, converters and acid electric furnaces. (6-169)
Bonding Mortar. M. W. Kellogg Co. This 2-page bulletin describes and illustrates Super Ignisite, an air-setting, super-high-temperature bonding mortar for use where ordinary high temperatures fail. (6-170)
Silicon-Carbide Refractories. American Crucible Co. (6-145)
Basic Refractories. Basic Refractories, Inc. (6-166)
Suspension Arches. Bigelow-Liptak Corp., Div. A. P. Green Firebrick Co. (6-131)
Plastic Super-Cement. Botfield Refractories Co. (6-94)
Refractory Coating Material. Brickseal Refractory Co. (6-67)
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Firebrick. Plibrico Jointless Firebrick Co. (6-129)
Silica Brick Cement. Charles Taylor Sons Co. (6-38)
Vitreous Silica Pipes, Fittings. Thermal Syndicate, Ltd. (6-50)

7. Welding

BRAZING AND SOLDERING

Silver Brazing Alloy. Handy & Harman. Details on how large and badly shattered tools can be readily reclaimed by brazing with Easy-Flo silver brazing alloy are presented in *Low Temperature Brazing News,* No. 28, two pages. (7-323)
Silver Brazing Alloy. Sherman & Co. This 4-page, pocket-size bulletin describes Nu-Braze, Grade 3, a silver brazing alloy that flows freely at 1300 F., for use in high-strength joints of copper, brass, bronze and other non-ferrous metals and alloys. (7-324)
Double-Strength Soldering Flux. Wolfe-Kote Co. The many advantages of Tri-flux, double strength No. 5, a triple-duty flux that cleans, removes rust, and fluxes, all in one operation, are discussed in a single sheet. (7-321)
Substitute Solders. American Smelting & Refining Co., Federated Metals Div. (7-256)
Indium Solders. Indium Corp. of America. (7-155)
Electric Furnace Brazing. Westinghouse Electric & Mfg. Co. (7-112)

ELECTRIC ARC WELDING

Tool Steel Electrodes. Alloy Rods Co. An attractive, 24-page catalog describes and illustrates Arcoloy extrusion tool steel arc welding electrodes for high-speed steel, air-, water-, oil- and work-hardening steel, and hot-working steel. Microphotos, tempering charts and engineering tables and data are included. (7-325)
Welding Symbols Chart. Hobart Brothers Co. The basic characters of welding symbols, as recommended by the American Welding Society, are illustrated in a new and informative wall chart. (7-318)
Handling and Storing Electrodes. National Carbon Co., Inc. Complete information on the correct and careful handling and storage of electrodes is presented in the first of a series of bulletins on electrodes, this one being four pages, well illustrated. (7-322)
Tool Steel Welding Electrodes. Welding Equipment & Supply Co. A variety of Eureka tool steel welding electrodes for metallic arc tool steel welding are described and illustrated in a 40-page catalog. (7-327)

Welding Stainless Steels. Allegheny Ludlum Steel Corp. (7-247)
Welding Equipment. American Agile Corp. (7-146)
Electrode Color Chart. Arcos Corp. (7-78)
Austenitic Stainless Steel Electrodes. Harnischfeger Corp. (7-110)
Arc Welding. Lincoln Electric Co. (7-303)
Arc-Welding Electrodes. McKay Co. (7-164)
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FLAME-PROCESSING

Machine Flame Cutting. Air Reduction Co. (7-301)

GAS WELDING

Low Temperature Welding Rods. Eutectic Welding Alloys, Inc. (7-288)

RESISTANCE WELDING

Resistance Welder Control. General Electric Co. (7-150)
Forge Welder. Progressive Welder Co. (7-157)
Resistance Welding Controller. Sciaky Brothers. (7-278)

SUPPLIES

Welding Positioners. Ransome Machinery Co. Bulletin No. 215, four pages, describes and illustrates welding and assembly positioning equipment, and includes specifications and load rating tables. (7-326)
Welding Positioners. Cullen-Friestedt Co. (7-220)
Fluxes. Krembs & Co. (7-221)
Welding Electrodes. A. O. Smith Corp. (7-261)
Welding Supplies. Victor Equipment Co. (7-241)

8. Metal-Working

FORMING

Pipe and Tube Mill Equipment, Etc. Aetna-Standard Engineering Co. A list of the products of this company—pipe and tube mill, strip finishing, continuous galvanizing equipment, etc.—is included in the 1944 annual report, 20 pages, well illustrated. (8-555)
Vertical Punches. Thomas Machine Mfg. Co. A standard line of steel plate vertical punches, electrically welded, as well as heavier cast frame punches, is presented in bulletin No. 303. (8-539)
Hole Punching Equipment. Wales-Strippit Corp. Type H horizontal hole punching units for punching holes in curved and straight flanges and rims are described and illustrated in an 8-page bulletin. (8-548)
Vertical-Horizontal Press. Watson-Stillman Co. Bulletin No. 330-A, four pages, profusely illustrates and describes a vertical-horizontal hydraulic press that is quickly converted by the rotation of a handwheel. Specifications are included. (8-536)
Pipe Bending Machine. American Pipe Bending Machine Co., Inc. (8-501)
Hydraulic Presses. Anderson Bros. Mfg. Co. (8-279)
Self-Contained Hydraulic Presses. Baldwin-Southwark Div. (8-65)
Oil Hydraulics. Denison Engineering Co. (8-307)
Hydraulic Presses. A. B. Farquhar Co., Ltd. (8-412)
Hydraulic Presses. Hydraulic Press Mfg. Co. (8-457)
Metal Extrusion Press. Hydropress, Inc. (8-210)
Double-Flaring Tool. Imperial Brass Mfg. Co. (8-348)
Hydraulic Presses. Lake Erie Engineering Corp. (8-248)

FORGING

Swaging Machine. Standard Machinery Co. (8-343)

MACHINING

Quick Analysis of Tapping Troubles. Henry P. Boggis & Co. This 4-page, illustrated bulletin, No. 15, presents a check list for quick analysis of tapping troubles, with suggested remedies and tap information. (8-541)
Oil Filters. Briggs Clarifier Co. Bulletin No. 107, four pages, describes and illustrates ZR Series oil filters for continuous filtration of soluble oils, low-viscosity cutting oils and kerosene in precision grinding, honing, etc. Specifications are included. (8-538)
Grinding Data Book. Carborundum Co., Refractory Div. Complete data on grinding, including an explanation of the new marking symbols, grading recommendations, safety rules, table of useful speeds, etc., are presented in a 136-page reference manual. (8-544)
Sump Tank Cleaning Machine. W. R. Carnes Co. The new "Model 50" sump tank cleaning machine for removing all sludge, chips, oil and coolant from sump tanks is described and illustrated in a 4-page bulletin. Specifications are included. (8-535)
Adjustable Cutting Tools. Robert H. Clark Co. Complete data on a variety of adjustable cutting tools, including counterbores, spot facers, hole cutters, etc., are presented in a 12-page, illustrated bulletin. Specifications are included. (8-553)
Gear Hobs. Colonial Tool Co., Ltd. Complete data on hobbing and hobs for cutting all types of gears, splines, etc. are presented in a 48-page, illustrated bulletin, No. H-44. (8-547)
Milling Machines. George Gorton Machine Co. Five models of adjustable, ram-knee type, super-speed milling machines, with either vertical or universal heads, are described and illustrated in bulletin No. 1400-C. Specifications are included. (8-545)
Oil Purifiers. Hilliard Corp. Hilco Airline oil purifiers, featuring "Contact" oil purifying for complete oil reconditioning, fuel dilution removed by vacuum, etc., are described and illustrated in a 4-page bulletin, No. A-102. Specifications are included. (8-550)
Diamond Tools. Larco Diamond Tool Co. This 22-page bulletin presents complete data on special diamond tools for boring, turning, etc. of non-ferrous metals, plastics, etc. Diagrams, specifications and prices are included. (8-551)
Carbide Tool Grinder. K. O. Lee Co. A variety of Universal carbide tool grinders are profusely illustrated and described in an attractive, 8-page bulletin. Specifications are included. (8-534)

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Eccentric Drive Counterbores, Etc. Moreland Tool Co. Complete data on eccentric drive counterbores, countersinks, core drill cutters and holders, etc., are presented in a well-illustrated, 20-page booklet. Numerous diagrams and specifications are included. (8-540)
Wheel and Tool Former. W. F. Myers Co., Inc. Information on how to form a tool bit, radii on a milling cutter, and a wheel, all with the Radiform wheel and tool former, is presented in a 12-page, well illustrated bulletin. (8-543)
Tool and Form Grinder. Norton Co. The Bura-way precision tool and form grinder, which lengthens tool life, increases production, etc., is described and illustrated in a 4-page bulletin. Specifications are included. (8-554)
Metal-Working Oil. Shell Oil Co., Inc. This 4-page brochure discusses Virgo Oil, a metal-working oil that minimizes cleaning problems and produces a cleaner finish. (8-546)
Precision Lathes. South Bend Lathe Works. An attractive, 64-page catalog, No. 100-D, describes and illustrates a complete line of engine, toolroom and precision turret lathes, and includes specifications. (8-549)
Machine Tools. Snyder Tool & Engineering Co. A variety of automatic-cycle, hydraulically-operated machine tools, including boring, drilling, miller machines, etc., are described and illustrated in a 32-page catalog. Diagrams and specifications are included. (8-552)
Tool Shanks and Cutter Bodies. American Brake Shoe Co., Brake Shoe & Castings Div. (8-361)
Vanadium, Cobalt Tool Bits. H. Boker & Co., Inc. (8-313)
Coated Abrasives. Carborundum Co., Globar Div. (8-366)
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Grinding Wheel Price List. Cleveland Quarries Co., Sterling Grinding Wheel Div. (8-481)
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Cutting Oil Purifiers. De Laval Separator Co. (8-323)
Tap Reconditioner. Detroit Tap & Tool Co. (8-529)
Tube Cutting Machine. De Walt Products Corp. (8-419)
Tantalum, Titanium, Etc. Carbides. Firth-Sterling Steel Co. (8-219)
Cutting Steels. General Aircraft Equipment, Inc., Metoloy Div. (8-244)
Cutting Tools and Gages. Greenfield Tap & Die Corp. (8-485)
Rotary Files. Grobet File Co. of America. (8-527)
Portable Electric Tool. H & H Research Co. (8-524)
Carbide Grinders. Hammond Machinery Builders. (8-239)
Carbide Tools and Blanks for Cutting Steel. Kennametal, Inc. (8-157)
Pressure Units. Mechanics Engineering Co. (8-532)
Carbide-Tipped Centers and Reamers. New England Carbide Tool Co. (8-454)
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Precision Grinding Wheels. Universal Wheel & Abrasive Corp. (8-377)

Liquid Honing Process. Vapor Blast Mfg. Co. (8-475)
Ball Joint Vises. Wall-Colmonoy Corp. (8-311)

ROLLING

Solid Steel Shear Knives. Heppenstall Co. (8-224)

METAL POWDER PROCESSING

Mixers, Agitators, Etc. H. K. Porter Co., Inc. of Pittsburgh, Pa. A complete line of process equipment, including mixers, agitators, blenders, dryers, tanks, pumps, etc., is presented in a well-illustrated catalog. (8-542)
Presses for Powdered Metals. Kux Machine Co. (8-62)
Metal-Powder Mixers. Patterson Foundry & Machine Co. (8-114)
Compressing Machines for Metal Powders. F. J. Stokes Machine Co. (8-119)

RIVETING AND FASTENING

Screw Thread Inserts. Aircraft Screw Products Co., Inc. (8-507)

9. Cleaning • Finishing

CLEANING

Metal Cleaners, Rust Preventives, Etc. F. A. Anderson Oil Co. This brochure contains three 6-page folders describing and illustrating Winsor metal cleaners, Winsor rust preventives, and Winsor metal working oils. (9-477)
Flat Spray Nozzles. Chain Belt Co. Bulletin No. 459, eight pages, profusely describes and illustrates Rex flat spray nozzles for use in washing, cleaning, cooling and descaling operations. Specifications are included. (9-472)
Solvent Degreasing. Detrex Corp. Fundamental operating principles in the use of chlorinated solvent degreasers, and important maintenance suggestions, are discussed in a 16-page, illustrated bulletin. (9-474)
Metal Cleaner. Oakite Products, Inc. The CrysCoat process, which first cleans the surfaces of ferrous metals and then coats them, thus providing a base for firm adhesion of organic finishes and prevents rusting of steel parts between operations, is discussed in a special service report, four pages. (9-470)
Industrial Cleaning Machines. Alvey-Ferguson Co. (9-251)
Electrochemical Descaling. Bullard-Dunn Div., Bullard Co. (9-88)
Metal Core Brush. Fuller Brush Co., Industrial Div. (9-463)
Pre-Cleaning for Plating. Macdermid, Inc. (9-110)
Cleaning Compounds. Magnuson Products Corp. (9-254)
Metal Cleaners. Mercury Chemical Co. (9-460)
Buffing, Polishing and Rubbing Compositions. Park Chemical Co. (9-123)
Heavy Duty Cleaning of Ferrous Metals. Pennsylvania Salt Mfg. Co. (9-129)
Surface Peening. W. W. Sly Mfg. Co. (9-422)

CHEMICAL TREATMENTS

Protective Finishes. Mitchell-Bradford Chemical Co. A variety of protective finishes, and their uses, are listed on a convenient, pocket-size card. (9-467)
Oxide Coating on Metals. Alrose Chemical Co. (9-167)
Blackening for Metals. Enthone Co. (9-259)
Black Steel Finish. Heatbath Corp. (9-185)
Bonderizing. Parker Rust Proof Co. (9-356)

ELECTROPLATING

Plating Equipment. Belke Mfg. Co. This 4-page bulletin describes and illustrates a complete line of plating equipment and supplies, and includes prices. (9-473)
Protective Coatings. B. F. Goodrich Co. Koroseal Tape RX and Korolac RX, two easy-to-apply protective coatings for plating racks, are described in a 4-page, illustrated bulletin, No. 8505. (9-479)
Anodizing. Kelite Products, Inc. The practice and technique of anodizing aluminum is presented in a well-illustrated, 16-page bulletin. Army and Navy specifications for protective treatment of aluminum and its alloys by anodizing are included. (9-465)
Corrosion-Resistant Metal Coating. Standard Steel Spring Co., Corronizing Div. The Corronizing process, consisting of electroplating ferrous or non-ferrous metals or alloys with thin layers of nickel and zinc and subjecting the coated metal to controlled heat temperatures, is described and illustrated in an 8-page bulletin. (9-469)
Selenium Rectifiers. Federal Telephone & Radio Corp. (9-442)
Rectifier Equipment. W. Green Electric Co., Inc. (9-252)
Electroplating Equipment. Munning & Munning, Inc. (9-308)
Formulas for Cadmium Plating. Turco Products, Inc. (9-178)

METALLIC COATINGS (NON-ELECTROLYTIC)

Hot-Dip Lead Alloy Coatings. Master Metalcoaters. (9-464)
Preparation for Metallizing. Metallizing Engineering Co., Inc. (9-239)

NON-METALLIC AND ORGANIC COATINGS

Plastic Coatings. American Pipe & Construction Co., Amercoat Div. This 16-page bulletin describes and illustrates the use of Amercoat plastic coatings in a wide range of industries. (9-462)
Resin Baking Coatings. Bakelite Corp. An attractive, 24-page bulletin profusely illustrates and describes phenolic resin baking coatings, and includes a list of tested and approved applications. (9-478)
Near Infra-Red Process. Fostoria Pressed Steel Corp. Complete data on the near infra-red process for baking, drying, preheating and dehydrating are presented in a well-illustrated, 20-page bulletin. (9-466)
Aluminum Coatings. Quigley Co., Inc. Triple-A Ready Mixed aluminum coatings for interior and exterior coating and the priming and sealing of old and new wood surfaces, and their application, are discussed in a pocket-size, 6-page folder. (9-476)
Metal Coating. Rheem Research Products, Inc. A single-page reprint discusses Iridite, an anti-corrosive treatment for zinc- or cadmium-plated surfaces. (9-475)
Spray Finishing Systems. Binks Mfg. Co. (9-362)
Corrosion Resistant Coatings. Cordo Chemical Corp. (9-415)
Protective Compounds. Glyco Products Co., Inc. (9-430)
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Zinc Corrosion-Resistant Coatings. United Chromium, Inc. (9-386)

PICKLING

Liquid Pickle Bath Toners. American Chemical Paint Co. Complete data on liquid pickle bath toners, Nos. 1 and 2, for improving the finish of pickled metals, are presented in Technical Service Data Sheet No. 13-15-1-2, two pages. (9-468)
Corrosion Resistant Ceramics. Atlas Mineral Products Co. (9-72)
Plastic Chemical Equipment. Haveg Corp. (9-435)
Ferric Sulphate and Cartridge Cases. Monsanto Chemical Co., Merrimac Div. (9-176)
Welded Equipment for Pickling, Annealing, Etc. Youngstown Welding & Engineering Co. (9-381)

POLISHING

Abrasive Belt Polishing Machine. Divine Brothers Co. The VM-DBX abrasive belt polishing machine for grinding welds or flat surfaces, deburring or abrasive belt polishing is described and illustrated in a two-page bulletin. Specifications are included. (9-458)
Abrasive Bands. DoAll Service Co. (9-398)
Burring, Grinding, Etc. Sturgis Products Co. (9-320)

MECHANICAL TREATMENTS

Shot Peening. American Foundry Equipment Co. Research data on shot peening and the fatigue of metals are presented in a booklet illustrated by microphotographs, charts and tables. (9-471)

10. Testing • Quality Control

CONTROL INSTRUMENTS

Ratio Control. Askania Regulator Co. This attractive, 16-page bulletin, No. 101, describes and illustrates a ratio regulator that operates on the jet pipe principle. An orifice calculation chart and numerous diagrams are included. (10-586)

Electronic Control. General Electric Co. The fundamentals and the various applications of electronic control are presented in a 12-page, illustrated bulletin, No. GEA-4126. (10-579)

Thermocouples, Etc. Revere Co. A variety of thermocouples, tubes, connectors, etc. are described and illustrated in a 4-page bulletin. Diagrams are included. (10-583)

Electrical Timing Devices. Wheelco Instruments Co. Both automatic and manual-type Inputrols—simplified electrical timing devices—are described and illustrated in two new bulletins, No. J403-2, four pages, and No. J402-2, two pages. Specifications for both types are included. (10-580)

Automatic Valve Operators. Automatic Temperature Control Co. (10-416)

Relays. Barber-Colman Co. (10-331)
Direct-Reading Dilatometer. Bristol Co. (10-514)
Temperature Control for Galvanizing Kettles. Brown Instrument Co. (10-234)
Heavy-Duty Weighing Scales. Detecto Scales, Inc., Detecto-Gram Scales Div. (10-464)
Flow Rate Meters. Fischer & Porter Co. (10-523)
Air-Operated Automatic Controller. Foxboro Co. (10-277)
Portable Pyrometer. Illinois Testing Laboratories, Inc. (10-568)
Conductivity Bridge. Industrial Instruments, Inc. (10-547)
Temperature Control. Leeds & Northrup Co. (10-560)
Portable Potentiometer Pyrometer. Lewis Engineering Co. (10-163)
Precision Instruments. P. R. Mallory & Co., Inc. (10-500)
Measuring Furnace Gases. Permutit Co. (10-195)
Optical Pyrometers. Pyrometer Instrument Co. (10-488)

HARDNESS TESTING

Equipment for Hardness Testing. Clark Instrument, Inc. (10-229)
Portable Brinell Hardness Tester. Andrew King. (10-148)
Hardness Testing Machines. Riehle Testing Machine Div., Am. Machine & Metals, Inc. (10-384)

INSPECTION DEVICES

Speed Measurement. General Radio Co. This 26-page booklet describes and illustrates the Stroboscope, a machine that permits a rotating object to be viewed intermittently, thus producing an optical effect of slowing down or stopping motion. (10-581)
Measuring Surface Roughness. Physicists Research Co. A technical supplement to *Profilometer Comments,* 12 pages, describes and illustrates how the Profilometer measures surface roughness through the application of electronic principles. A list of attachments and accessories is included. (10-582)
Gages and Dial Indicators. B. C. Ames Co. (10-498)
Surface Measuring Oscillographs. Brush Development Co. (10-491)
Precision Instruments. Continental Machines, Inc. (10-526)
Height Gage. Federal Products Corp. (10-569)
pH Meters. Gamma Instrument Co. (10-334)
Magnaflux. Magnaflux Corp. (10-288)
Demagnetizers. Magnetic Analysis Corp. (10-558)
Inspecting Surface Finishes. Rex D. McDill. (10-577)
Optical Tools. Polan Industries. (10-575)
Abrasive Wear Tests. Taber Instrument Co. (10-233)

MECHANICAL TESTING

Testing Laboratory. F. A. Pease Laboratories. A 6-page, pocket-size folder discusses the type of service provided by this company, including chemical and spectrographic analysis, physical testing, etc. (10-585)
Testing Equipment. Baldwin-Southwark Div. (10-121)
Dynamometers. W. C. Dillon & Co., Inc. (10-338)
Impact Testing Machine. Tinius Olsen Testing Machine Co. (10-298)
Tensile Testing of Fine Wire. Henry L. Scott Co. (10-55)

RADIOGRAPHY

Films for Industrial Radiography. Ansco. (10-278)
Protection From X-Rays. Bar-Ray Products. (10-374)
Industrial Radiography with Radium. Canadian Radium & Uranium Corp. (10-261)
X-Ray Film. Eastman Kodak Co. (10-170)
The X-Ray in Industry. General Electric X-Ray Corp. (10-10)
Industrial X-Ray. Kelley-Koett Mfg. Co., Inc. (10-185)
X-Ray Equipment. North American Philips Co., Inc. (10-559)
X-Ray Equipment. Picker X-Ray Corp. (10-503)
X-Ray Machine. Standard X-Ray Co. (10-299)

SPECTROGRAPHY

Universal Spectrophotometers. Wilkens-Anderson Co. (10-180)

LABORATORY AIDS

Gas Analysis Apparatus. Burrell Technical Supply Co. Typical new models of gas analysis apparatus are described and illustrated in a 4-page bulletin. (10-584)
Laboratory Equipment. Central Scientific Co. (10-507)
Moisture Tellers. Harry W. Dietert Co. (10-411)
X-Ray Diffraction Tubes. Machlett Laboratories. (10-551)

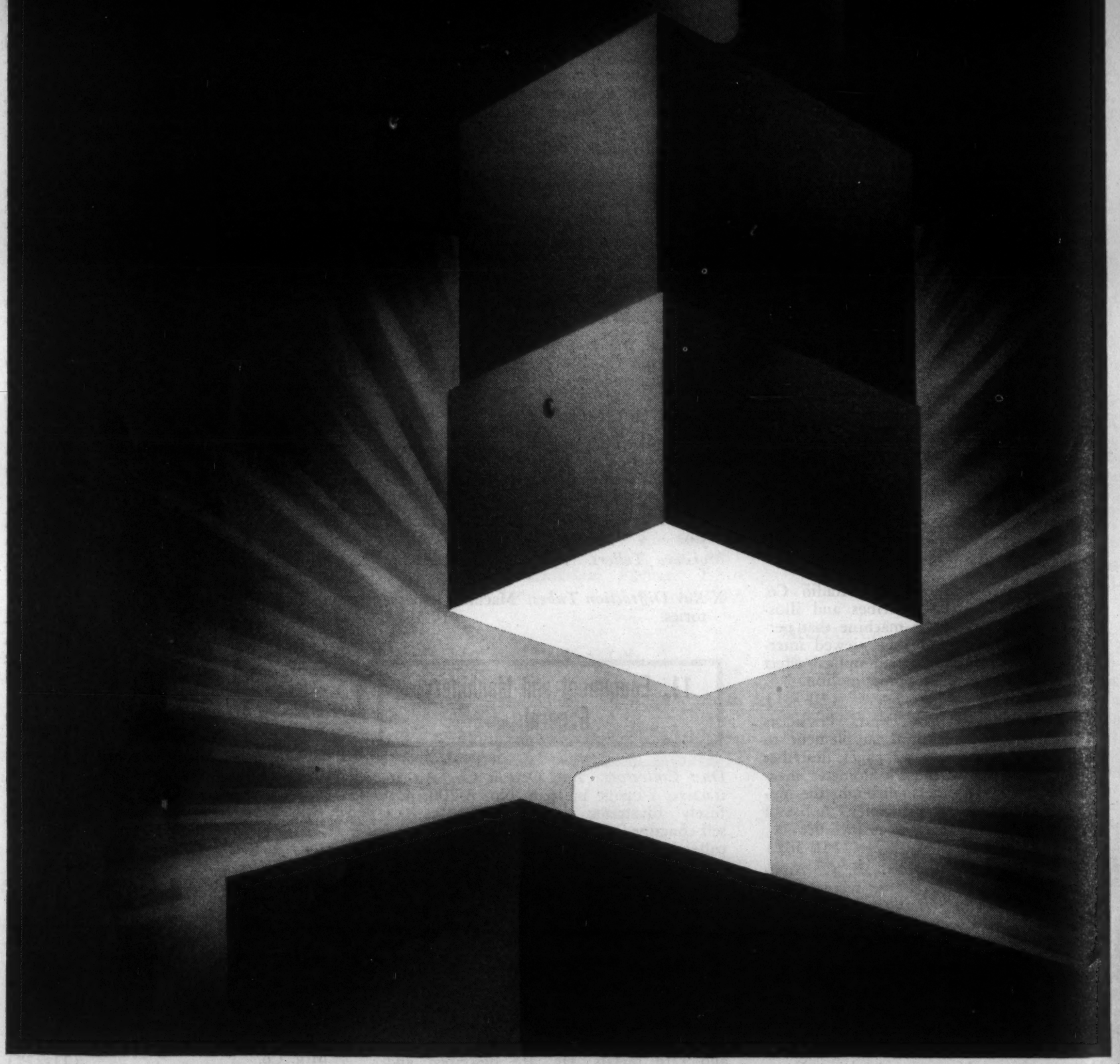
11. Equipment and Machinery, General

Dust Collectors. Aget-Detroit Co. An attractive, 24-page bulletin, No. A-200, profusely illustrates and describes various self-contained Dustkop dust collectors for collecting dust from all sizes of surface, tool, pedestal and disc grinders and sanders. Specifications are included. (11-282)
Junior Pug Mill. Wm. M. Bailey Co. A junior pug mill, single paddle shaft, for conditioning fine dust, mixing and moistening granular materials is described and illustrated in a 2-page bulletin. (11-278)
High Vacuum Pumps. Beach-Russ Co. Rotary-piston high vacuum pumps for impregnating castings, refining magnesium and rare metals, etc. are described and illustrated in a 12-page bulletin, No. 80. (11-286)
Continuous Printer. Charles Bruning Co., Inc. The BW-Copyflex Model 2 continuous printer for both copyflex materials and BW prints is described and illustrated in a 4-page bulletin. (11-290)
Heat Exchangers. Downington Iron Works, Heat Transfer Div. Complete data on a variety of heat exchangers for use in steam heaters, liquid and vapor coolers, etc., are presented in a 24-page, illustrated bulletin. Specifications are included. (11-284)

Please Use the Coupon on Page 1713

Air Filter. Drayer & Hanson, Inc. Complete data on the Wat-R-Miser air filter are presented in this well-illustrated, 16-page bulletin, No. 3B. Numerous diagrams and tables are included. (11-288)
Variable Speed Drive. Lombard Governor Corp. Complete data on the new variable speed drive, and ten important new features, are presented in a 4-page, illustrated bulletin. (11-285)
Hydraulic High-Lift Truck. Lyon-Raymond Corp. This 4-page folder, No. 136, describes and illustrates a light-weight, hydraulic high-lift truck that picks up, transports and elevates heavy unwieldy work with the minimum of maneuvering. Specifications are included. (11-279)
After-Cooler. Niagara Blower Co. A new method of compressed air after-cooling with the Aero after-cooler which cools water for inter-cooler and compressor jackets, etc., is described and illustrated in Bulletin No. 98, two pages. (11-287)
Wire Handles. E. H. Titchener & Co. Numerous styles of wire handles for all types of tools are profusely illustrated and described in a 24-page bulletin. (11-281)
Industrial Vacuum Equipment. Vacuum Engineering Div., National Research Corp. A varied assortment of bulletins, full-page diagrams and photographs are assembled into one booklet describing a thermocouple vacuum gage control, a vacuum diffusion pump, evaporators, etc. Specifications are included. (11-280)
Electronic Supplies. Walker-Jamieson, Inc. This 32-page booklet lists a complete line of electronic supplies, including X-ray machines, timers, resistors, condensers, etc., that are available from stock and may be had for immediate delivery. (11-283)
Air Conditioning Equipment. Westinghouse Electric Elevator Co. Suggestions on how to plan for post-war air conditioning are presented in a 16-page, illustrated booklet. (11-289)
Pumps and Hydraulic Equipment. Aldrich Pump Co. (11-116)
Filters. Cuno Engineering Corp. (11-121)
Magnetic Separators. Dings Magnetic Separator Co. (11-232)
Refrigeration and Air Conditioning Equipment. General Electric Co. (11-243)
Fluid Cooler. Gray-Mills Co. (11-211)
Preparing Engineering Reports. Alexander Hamilton Institute. (11-113)
Dryers, Kilns, Coolers. Hardinge Co. (11-64)
Hydraulic Equipment. Hydraulic Machinery, Inc. (11-201)
Impregnating Castings. Jackson & Church Co. (11-222)
Marking Devices. Marquette Engraving & Mfg. Co. (11-277)
Dust Preventives. Parsons Engineering Corp. (11-233)
Acid Proof Cement. Pennsylvania Salt Mfg. Co. (11-71)
Air Processing Equipment. Peters-Dalton, Inc. (11-218)
Technical Books. Reinhold Publishing Corp. (11-273)
Portable Sump Tank. Spencer Turbine Co. (11-219)
Progressive Lubricating System. Stewart-Warner Corp. (11-239)
Industrial Fluorescent Lighting. Sylvania Electric Products, Inc. (11-265)
Dust Collector. U. S. Hoffman Machinery Corp., Filtration Div. (11-210)
Cleaning Furnace Flues. Vacuum Conveyor Co. (11-275)

Molybdenum die steels serve particularly well where heavy dies require deep hardening.



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

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Climax Molybdenum Company

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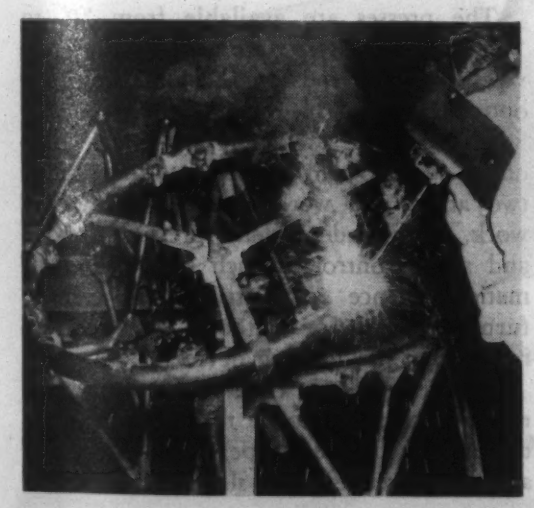
MOLY

METALLURGICAL ENGINEERING news

Equipment ● *Finishes* ● *Materials* ● *Methods* ● *Processes* ● *Products*
Alloys ● *Applications* ● *Designs* ● *People* ● *Plants* ● *Societies*

High Tensile Electrode for Aircraft

A new high tensile arc welding electrode for fabricating aircraft steels is announced by the *Electric Welding Div., General Electric Co.,* Schenectady. Known as Type W-55, it can weld in any position, including vertical welding from the top down and from the bottom up.



The arc can be struck at the top of the joint and maintained while welding vertically downward, then overhead, then vertically upward back to the starting point. The arc has sufficient force to keep slag from crowding the electrode when welding vertically downward, and the metal sets up quickly when welding overhead and vertically upward.

Arcing characteristics provide flexibility over a reasonably wide voltage range with stable operation throughout. The high tensile strength deposit is comparable to the mechanical properties of the parent metal. It is especially recommended for welding engine mounts and fuselage assemblies.

Characterized by its grey extruded coating, it is suitable for operation on d.c. straight polarity or a.c. A medium to long arc is recommended. It is available in three sizes.

Aircraft Bore or Rivetscope

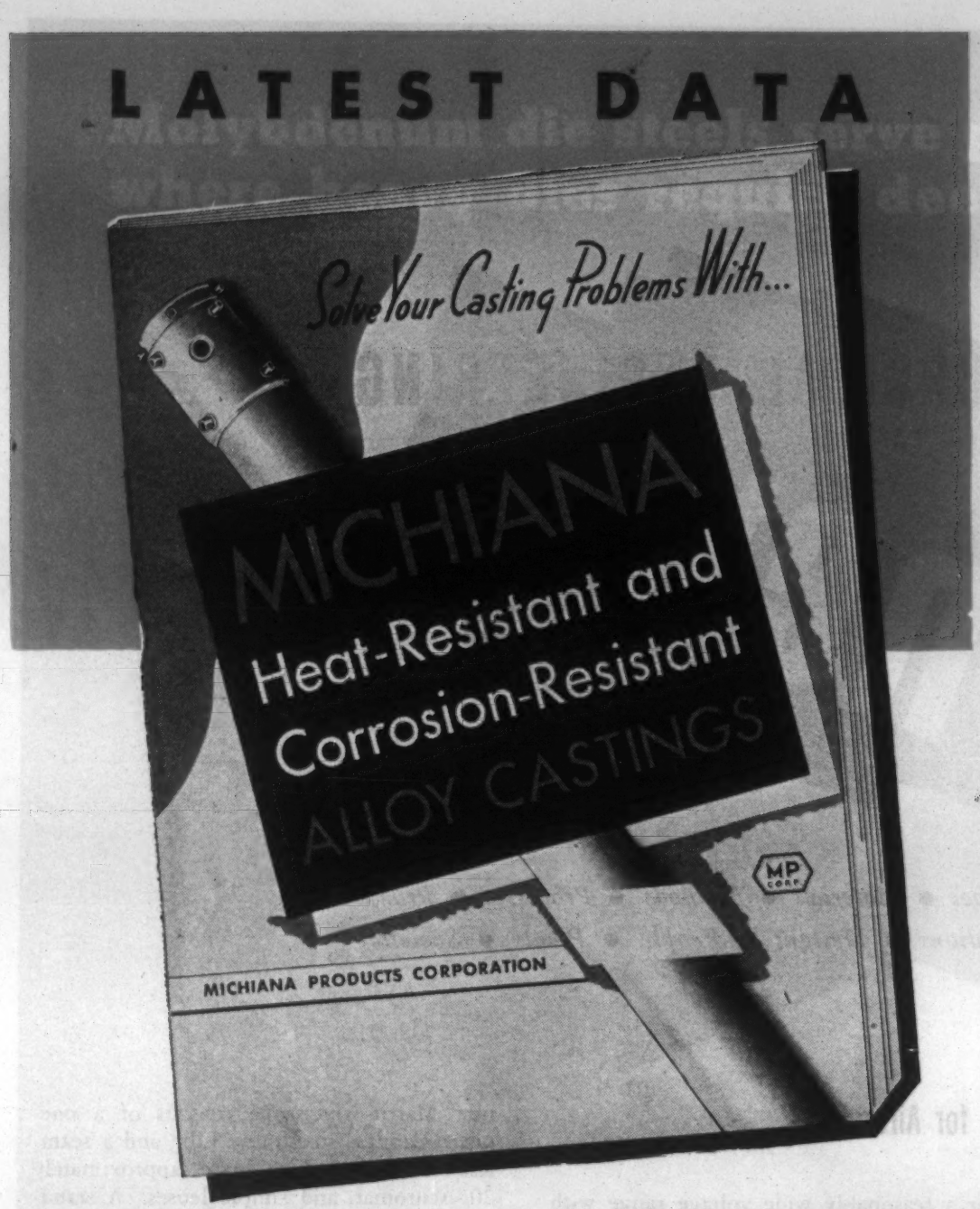
A bore or rivetscope, 110 in. long, with only ⅝-in. outside diam. for checking blind rivets, has been developed by Dr. George S. Crampton, *Lenox Instrument Co.,* in collaboration with engineers of the inspection department of the *Glenn L. Martin Co.,* Baltimore 3. Its purpose was originally to inspect blind rivets in a new type wing construction that would not admit most existing borescopes and could not be reached throughout its entire length by those which it would admit.

Previously, it was necessary to X-ray the entire wing and piece together to determine whether the individual rivets were properly set—an impractical method. The new Martin rivetscope consists of a one-piece seamless steel outer tube and a seamless steel liner, which spaces approximately 20 Achromat, and simple lenses. A standard eye piece is provided at one end, together with a connection for a six-volt transformer, while the other end carries a light and mirror similar to those in a conventional borescope. Lenses are ground to provide a 2X magnification at the eye piece.

A metal foot that rides over rivets is at the scope end of the tube to facilitate sliding it into long narrow sections, such as corrugations. The outside tube is scaled in feet and inches to help locate defective rivets. Wooden stands with plastic rollers support the instrument during inspection.

It weighs 10 lb., and does much inspection work from defective rivets in bomb bay fairings to long lengths of defective tubing.

● Full protection and utmost in comfort are provided by safety goggles with shatterproof Tenite plastic frames. Extra large lenses permit unobstructed vision. Lenses are interchangeable so that different colors may be inserted. They are molded by *Vlchek Tool Co.* for the *Kimball Safety Products Co.,* both of Cleveland. Tenite is made by *Tennessee Eastman Corp.,* Kingsport, Tenn.



ON MICHIANA HEAT- AND CORROSION-RESISTANT ALLOYS

War-time demands have demonstrated still further the ability to maintain uniform high standards in the production of MICHIANA Alloy Castings. Improved facilities and foundry technique,—added experience in meeting the requirements of a host of America's most important industrial organizations assure your getting castings that fit your exact requirements.

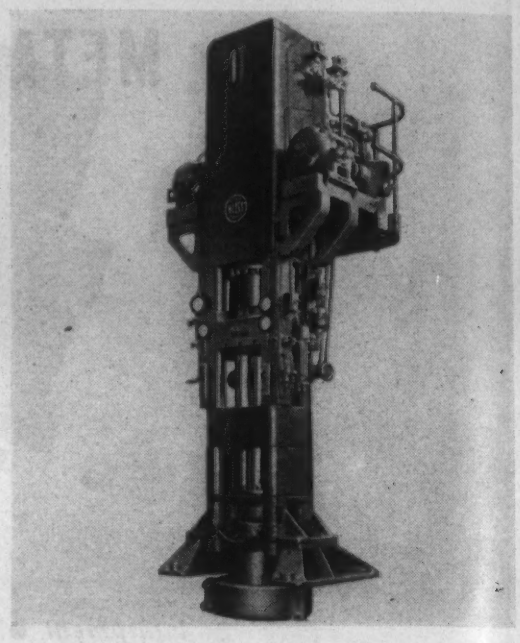
Our new literature contains the data on the various leading alloys with illustrations to indicate the wide range of usage. A copy of this new Booklet No. 110 will be mailed on request. MICHIANA PRODUCTS CORPORATION, Michigan City, Ind.

MICHIANA
Heat-Resistant and
Corrosion-Resistant
ALLOY CASTINGS

- Muffles
- Boxes
- Rails
- Rolls
- Sprockets
- Retorts
- Pots
- Grids
- Tubes
- Chains
- Heat Exchangers

Hydraulic Press for Powder Metals

A specially designed duplex hydraulic press for the powder metal industry is heralded by *E. W. Bliss Co.*, 53rd St. & Second Ave., Brooklyn 32. This 200-ton press is for pressing deep sections and flanged objects in powdered metals where-



in one portion of the work must be pressed at a different speed than another.

The press features independent pressure control, stroke control and speed control of each slide. Separate pumping units are for each slide so that the relation of speeds of the two slides can be infinitely varied.

An automatic cycle is provided with the following sequence: Quick closing to the work; simultaneous pressing by the two slides at predetermined adjustable speeds and pressures; automatic reversal of upper slide; use of lower slide as ejector; timed pause for loading and automatic return of lower slide.

The presses are available from 50- to 5000-ton capacity. Automatic loading devices and core rods for bushing work are optional.

In addition to duplex presses, Bliss offers designs with as many as four slides, two above the work and two below the work, with independent pressure, stroke and speed control of each slide and automatic sequence as desired. They can be furnished with or without core rod arrangement and loading devices.

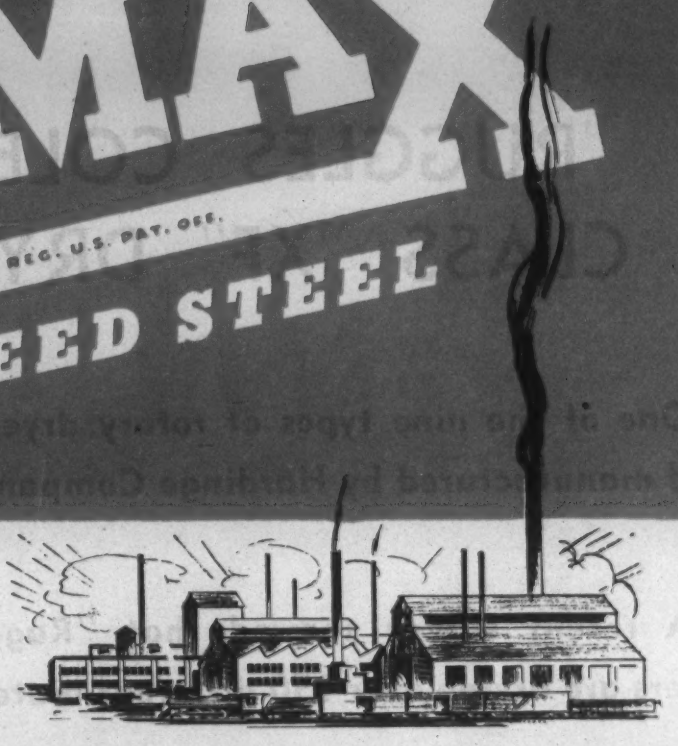
All have electric control permitting the required sequence to be readily changed in the event a different type of work required a different sequence of slide.

● *Western Electric Co.* has added the thermistor to its list of electronic and communications equipment being manufactured. It will have many peacetime applications. Thermistors may be used as flow meters, vacuum gages, or, in general, to measure physical quantities dependent on the flow of thermal energy from a hot body. When used as resistance thermometers, precision greater than that obtainable with thermocouples is possible.

SPECIFY MO-MAX

TRADE MARK, REG. U.S. PAT. OFF.

HIGH SPEED STEEL

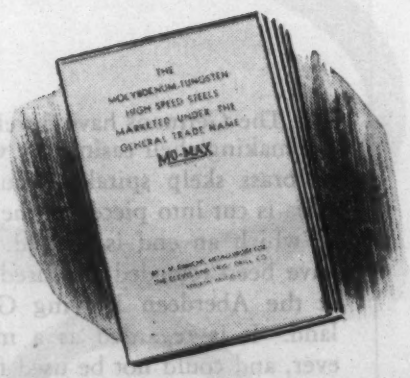


It is estimated that at the height of the war effort there were in operation in American industrial plants about TWO MILLION machine tools. The greater proportion of these machines use cutting tools – lathes, drills, planers, shapers, millers, gear cutters, threading machines, to mention but a few. Because of radical changes in manufacturing methods, it is believed that only one out every four of these machine tools will be adaptable to post-war production.

For Heavy Cuts ... At High Speeds ...

The combination of great toughness and a high degree of hardness give MO-MAX superior cutting ability. This makes possible heavy cuts and the use of high speeds in a wide range of cutting operations.

Cutting tools made from MO-MAX, in actual tests, show 20% more work per grind per tool than those made from other steels. That advantage may be the difference between operating your machines economically or wastefully.



Send for your copy of this booklet.

THE *WHY* AND *HOW* OF MO-MAX

This is not a booklet prepared primarily for selling purposes. Its 52 pages of sound, scientific facts trace the eleven-year development of molybdenum-tungsten steel. Photographs and graphic charts make the text easy to understand and gives operating and handling instructions for its proper use.

Address: THE CLEVELAND TWIST DRILL CO. • 1242 East 49th Street, Cleveland 14, Ohio

THEY'RE ALL MO-MAX

"LMW" ...
Allegheny Ludlum Steel Corp.

"Mohican" ...
Atlas Steels, Ltd.

"Bethlehem HM" ...
Bethlehem Steel Company

"Mo-Cut" ...
Braeburn Alloy Steel Corp.

"Star Max" ...
The Carpenter Steel Co.

"Molite 8" ...
Columbia Tool Steel Company

"Rex-T-Mo" ...
Crucible Steel Co. of America

"Di-Mol" ...
Henry Disston & Sons, Inc.

"Rex-T-Mo" ...
Halcomb Steel Co.

"Mogul" ...
Jessop Steel Company

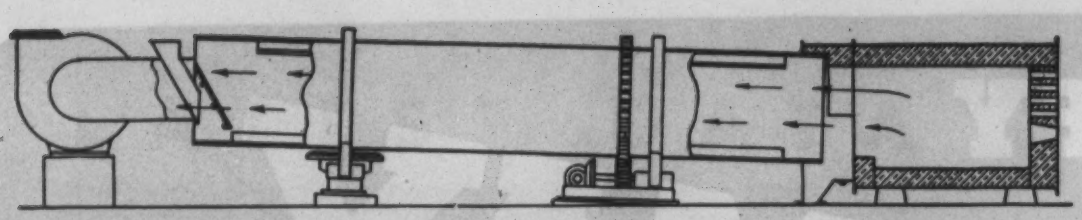
"Tatmo" ...
Latrobe Electric Steel Co.

"S. T. M." ...
Simonds Saw and Steel Co.

"Mo-Tung" ...
Universal-Cyclops Steel Corp.

"8-N-2" ...
Vanadium-Alloys Steel Co.

"Vul-Mo" ...
Vulcan Crucible Steel Co.



"RUGGLES COLES" CLASS "XF" DRYER

One of the nine types of rotary dryers designed and manufactured by Hardinge Company Inc.

A recent survey showed that "Ruggles-Coles" dryers are drying over 150 different materials.

If you have a problem requiring the drying of any material, let us recommend the proper dryer.

HARDINGE EQUIPMENT

	Bulletin No.
Agitators	31-C
Clarifiers	31-C
Classifiers, Air	17-B
Classifiers, Counter-Current	39-A
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Thickeners	31-C

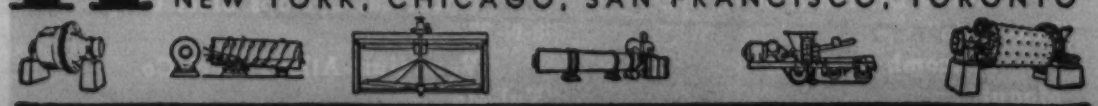
A few of the materials we are now drying.

Coal
Coke
Charcoal
Moulding Sand
Granulated Slag
Limestone
Aluminum Chips
Stainless Steel Turnings
Ores
Chemicals

Write for Bulletin 16-C.

HARDINGE

COMPANY, INCORPORATED - YORK, PENNSYLVANIA
NEW YORK, CHICAGO, SAN FRANCISCO, TORONTO



D-31

All-Purpose Disc Grinder

A new all-purpose disc grinder for any type of metal, wood or plastic material has been developed by the *Kindt-Collins Co.*, 12651 Elmwood Ave., Cleveland 11. It is made in two similar models, regular and heavy-duty, the regular model employing an inch-thick, heavy-duty grinding disc.

Principal features of design and construction are (1) the 30-in. disc with 26-in. high grinding area; (2) hydraulic controls that eliminate all gears, worms and jack screws ordinarily employed for raising, lowering and tilting the table; (3) an accurate position stop provided on protractor for stopping table in any position from 45° down to 15° up; (4) ventilated table with properly placed perforations to channel dust into highly efficient dust guards; and (5) paper or cloth discs may be removed and replaced without removing the steel disc.

Ease and simplicity of operation are features. A conveniently-located handle operates the hydraulic valve and a 10-in. handwheel controls every hydraulic operation. Start and stop button control is mounted at eye level on the front of the machine. The table, 37½ in. from the floor, will tilt 45° down and 15° up, and can be lowered to 4 in. from the bottom of the disc. Protractor degrees are large and clearly engraved.

The motor is mounted on a hinged pedestal over the shaft, driving the main shaft through three V-belts and thus making possible highly accurate speeds for efficient grinding. Disc speed is 800 r.p.m., giving a rim speed of 6260 r.p.m. The regular model is equipped with a 3-h.p., ball bearing, 1150 r.p.m., a.c., 2- or 3-phase motor, while the heavy-duty unit uses a 5-h.p. motor of the same type.

Floor space required is only 41 in. by 38½ in., over-all height is 57⅜ in., and total shipping weight is 2100 lb.

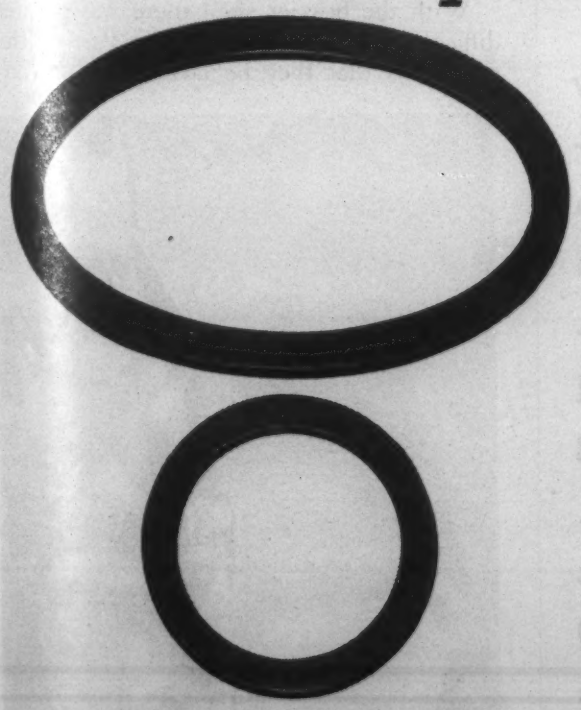
● The Germans have developed a method for making shell casings by winding a piece of brass skelp spirally around a mandrel. This is cut into pieces of the proper length, to which an end is welded. These casings have been reloaded and fired over 30 times at the Aberdeen Proving Grounds, Maryland. It is regarded as a makeshift, however, and could not be used for naval work.

Tap Grinding Fixtures

A new tap grinding fixture, adaptable to any tool grinder, is now under production at the plant of *K. O. Lee Co.*, Aberdeen, S. Dak. The unit is compact, sturdy, handy, and of latest design. Maximum accuracy is maintained on taps through the use of collets. It will accommodate taps from No. 8 to 2½ in. in diam.

All grinding operations necessary on taps can be accomplished with one set-up. These include grinding the relief, grinding the flutes, and salvaging broken taps. Two to six flute taps can be ground, either right or left.

These small welded STEEL RINGS *help keep them up there!*



The oval and round welded steel rings shown above are for the inlet and exhaust flanges of super-chargers.

High altitudes for America's war planes have been made possible through the use of super-chargers. These super-chargers in turn utilize welded high grade steel rings for their inlet and exhaust flanges. Such rings are but one of the many war products made by The Cleveland Welding Company.

When peace returns we will of course be making rolled and welded steel hoops, bands and rings for a wide variety of peacetime uses. We invite your inquiry on products such as these for volume production. Write today and tell us about your requirements.

the Cleveland
WELDING COMPANY
WEST 117th STREET at BEREA ROAD • CLEVELAND 7, OHIO

CHECK
BLOWERS
AND EXHAUST
SYSTEMS
Instantly
with the **Alnor Velometer**

This instantaneous direct reading air velocity meter measures air speed in feet per minute. There are no calculations, no timing, no conversion tables; its use is so simple that anyone can take accurate measurements with the Velometer. Extension jets permit correct readings in many locations that would be difficult or impossible to reach with other means of measurement.

Keep exhaust equipment working efficiently by regular checks for draft, leaks, blower operations, etc., with the Alnor Velometer. You can get accurate information on performance with a few minutes' inspection at regular intervals.

The Velometer is made in several standard ranges from 20 fpm to 6000 fpm and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for Velometer bulletins.

Velometer used for positive static pressure readings

ILLINOIS TESTING LABORATORIES, INC.
420 North La Salle Street
Chicago 10, Illinois

Omissions from Our "Packaging" Article

The following letter was received from the *United States Stoneware Co.*, 60 E. 42nd St., New York 17: "Your article, 'Protection of Steel Parts for Overseas Shipment,' which appears in the October issue of METALS AND ALLOYS, is very interesting, with this reservation: You have not included any mention of our 'Tygon Tempro-Tec.' We are selling this very widely throughout the metal-finishing industries for exactly the purpose covered by your article."

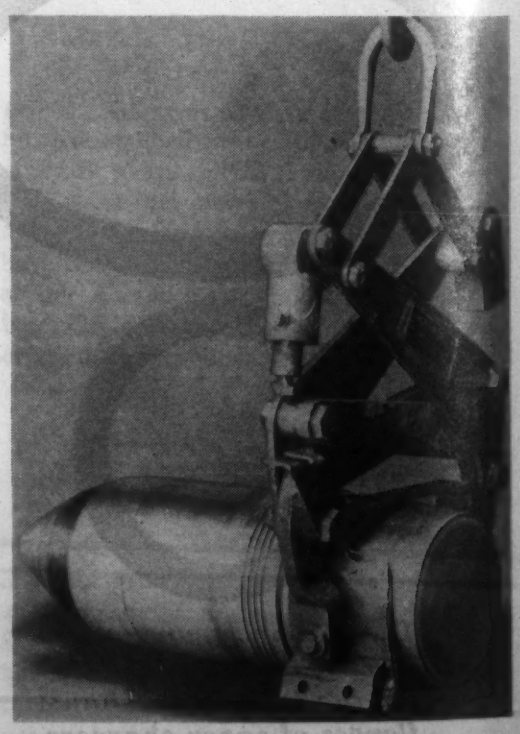
The editors have also had called to their attention "Plastic Peel," made by *Hercules Powder Co.*, Wilmington, Del., which is a corrosive resistant coating, easily removed by slitting and stripping from the part.

The *Youngstown Miller Co.*, Sandusky, Ohio, makes a plastic coater machine that dips spark plugs with an ethyl cellulose coating at the rate of 4500 plugs per hr. The machine includes conveyor and heating equipment.

Automatic Tongs for Shells

Special automatic tongs that had been items of individual design are now being mass produced for handling military shells by *Heppenstall Co.*, Pittsburgh. The tongs can be used in series to handle shells from the first operation to the last. They tie in with conveyor belts, and are particularly good for the heavier 8- and 9-in. shells, which tend to supplant the 5- and 6-in. shells which do not afford enough fire power in this modern war.

With the heavier shell there was greater difficulty in handling by hand. Part of the routine is that they be taken from a conveyor in a horizontal position and placed in a vertical position, and vice versa, to shot blast the inside chamber of the shells and for the welding process.



These shells usually weigh 250 lb. One of the largest Heppenstall tongs has a lifting capacity of 60,000 lb.

KEEP YOUR KNOWLEDGE OF CARBON AND ALLOY STEELS UP-TO-THE-MINUTE!

Write for These Two NEW Lebanon Reference Charts

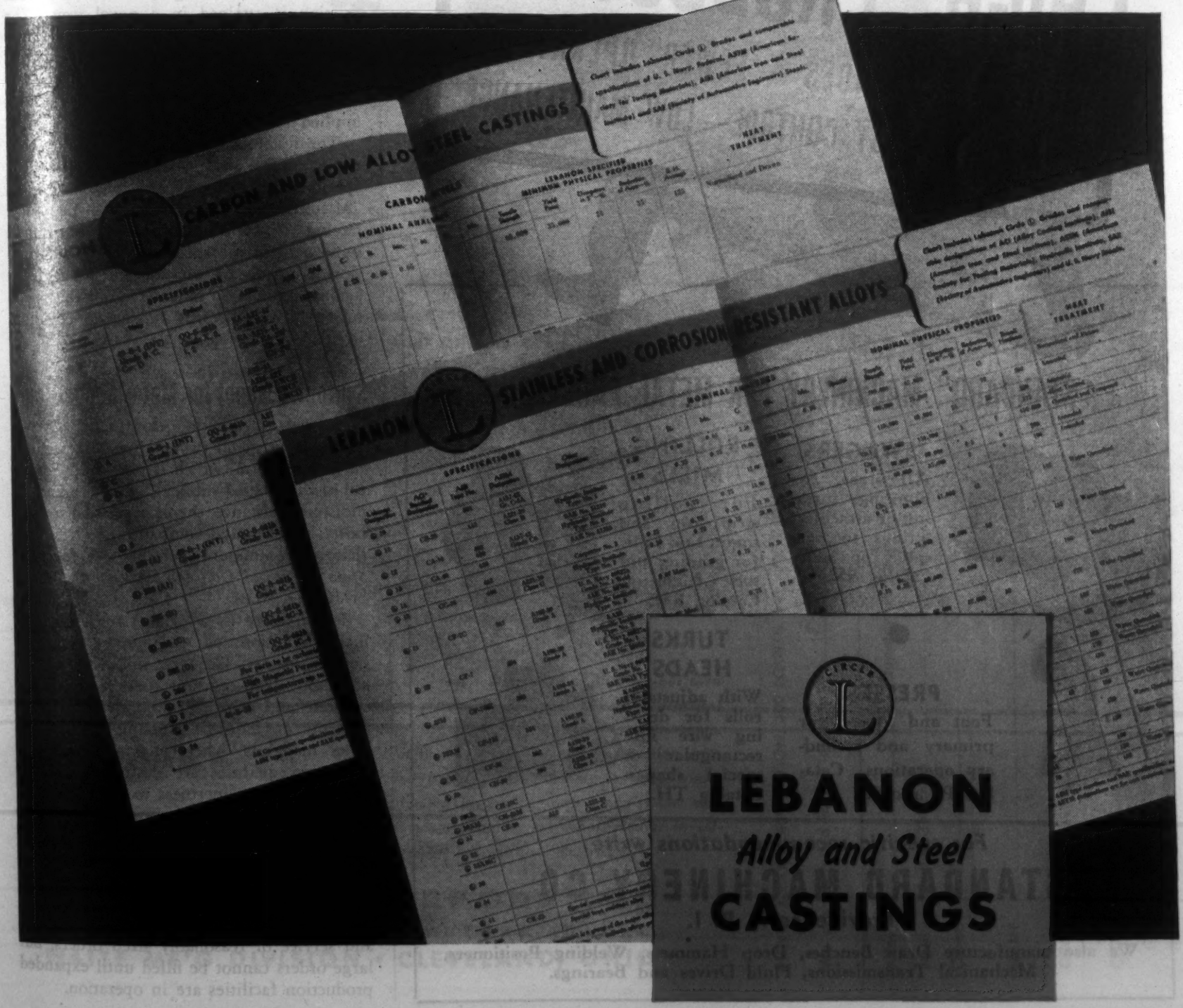
WITH big production changes ahead, knowledge of materials must be up-to-the-minute. That's why Lebanon Steel Foundry now issues revised editions of its widely circulated charts on Lebanon Circle (L) Stainless, Corrosion and Heat Resistant Alloys and on Lebanon Circle (L) Carbon and Low Alloys.

First issued three years ago, these charts have been popular among steel castings users because they provide helpful information in handy form. They're file-size . . . and so designed that information is available at a glance without thumbing pages. Both charts show comparable specification designations (including wrought and cast materials), analyses, physical properties and heat treatment.

Executives, engineers and metallurgists may obtain copies of these concise, up-to-the-minute reference charts, without charge, by writing to Lebanon Steel Foundry.

LEBANON STEEL FOUNDRY **LEBANON, PA.**

ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD



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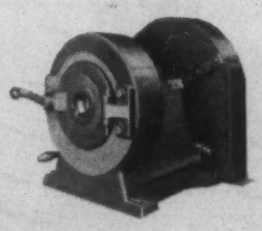

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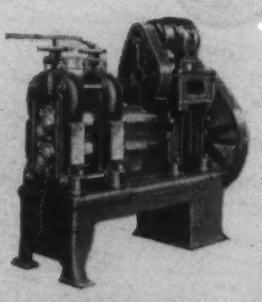
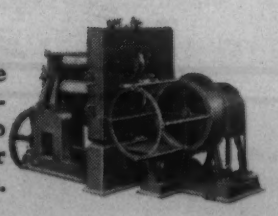
All sizes, for pointing, forming or attaching fittings to bar, cable or tube. Catalog SM.

ROLLING MILLS
For rolling strip, rod, and ingot. End Mills for grading and tube forming. Catalog RM.



PRESSES
Foot and Power, for primary and secondary operations. Catalogs PP and PF.

TURKS HEADS
With adjustable rolls for drawing wire into rectangular or special shapes. Catalog TH.



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We also manufacture Draw Benches, Drop Hammers, Welding Positioners, Mechanical Transmissions, Fluid Drives and Bearings.

Two Hardness Testing Machine Accessories

Two new pieces of equipment were displayed for the first time at the Metal Show in Cleveland by the *Wilson Mechanical Instrument Co., Inc.*, 383 Concord Ave., New York 54, sole maker of the Rockwell hardness tester. One is called the "Equitron" and the other the "Tukon" tester.

The Equitron fixture properly supports the specimen for end quench test for hardenability of steel (the Jominy end quench test), and accurately positions the sample for each successive Rockwell test at 1/16-in. intervals. The fixture is quickly clamped to the elevating screw by a nut. Ground surfaces support the underneath surface of the specimen. The sample does not rock or tip as the tests are made despite the required moving of the sample.

Accurate spacing is done by a wheel and handle at one end of the fixture. One revolution of the wheel moves the specimen 1/16 in. A ball click indexing mechanism indicates each 1/16-in. spacing. The sample is held in indexed position by spring pressure. Tests can be made up to 2½ in. from the quenched end.

The Tukon tester is for determination of Knoop hardness numbers under testing loads of 25 to 3600 grams. Freedom from friction is attained in a novel way. The penetrator, though carried by a balance beam, always applies its load truly normal to the surface tested and at the fixed rate of 6.5-mm. a minute. The load remains applied for a definite period.

The tester is fully automatic under electronic control in a synchronous cycle. The specimen is mounted and placed on the "Microton" (a special micrometer stage having 2-way adjustment for horizontal movement of the specimen). The indentation is made by elevating the specimen against the Knoop indenter, until the specimen's hardness resists further indentation.

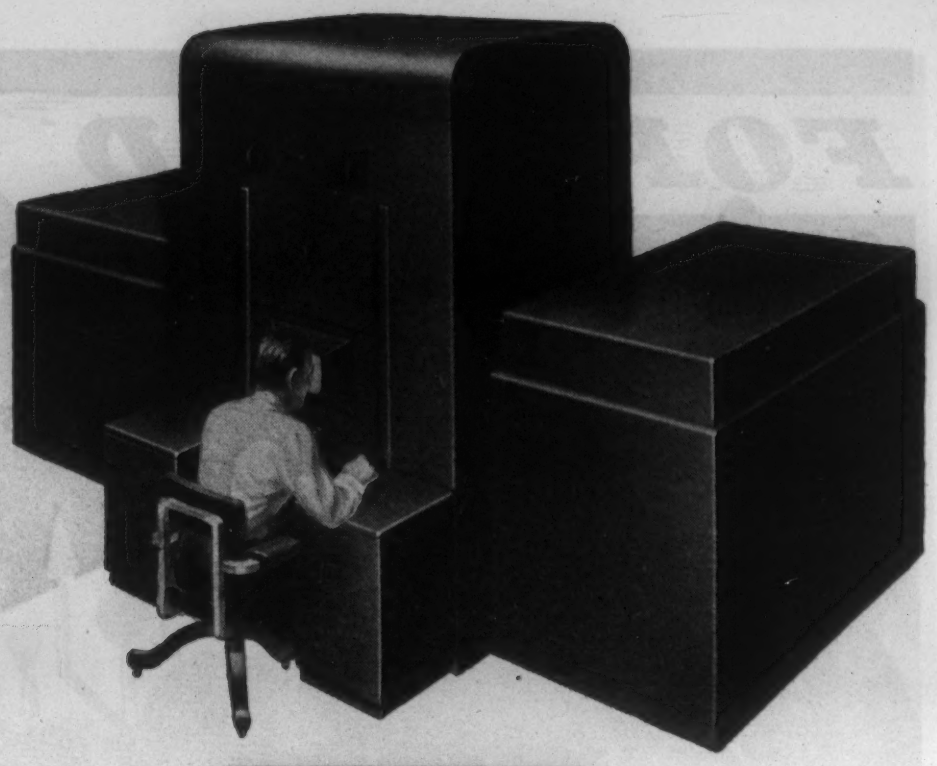
Synthetic Isopol for Metal Applications

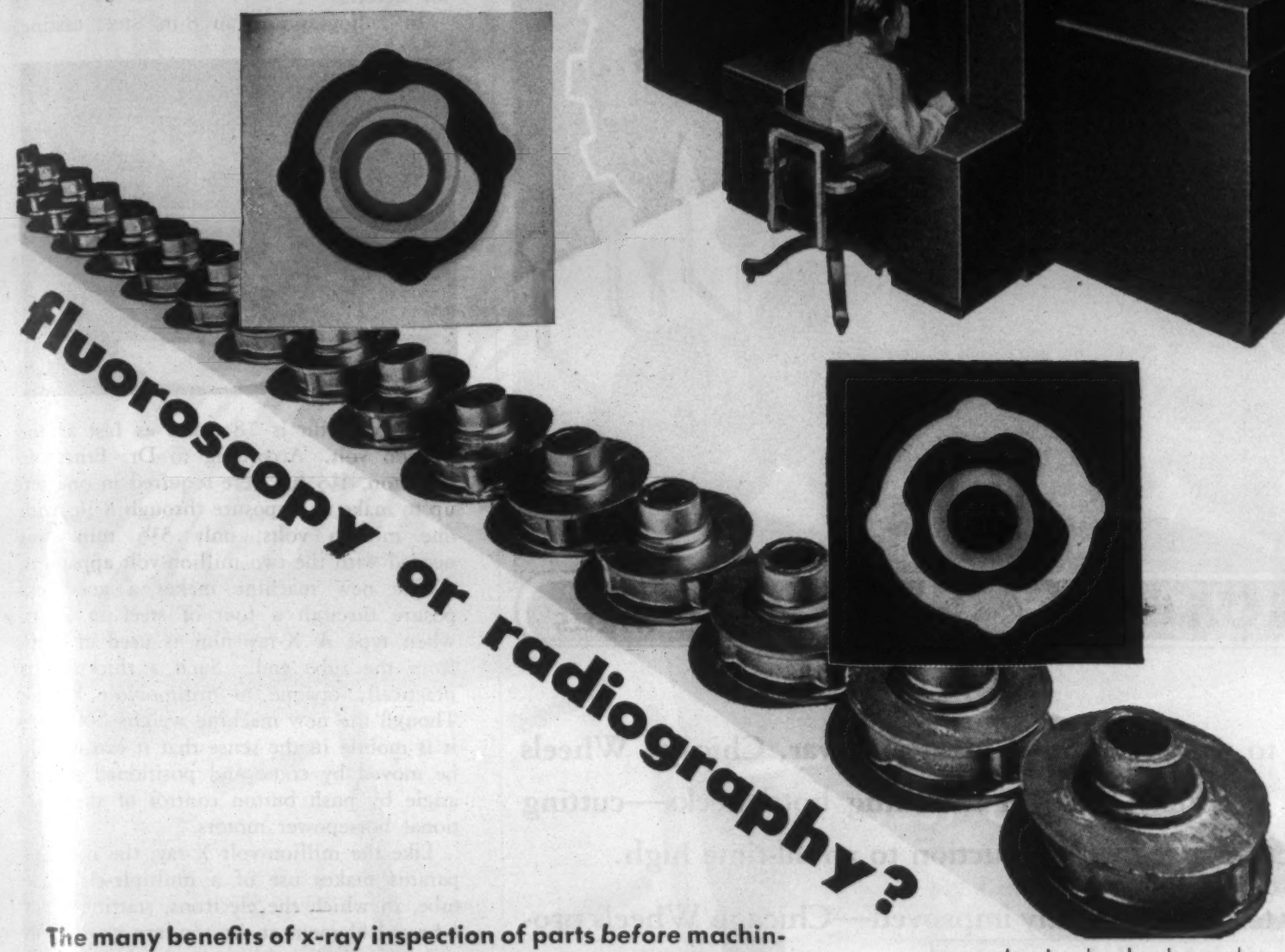
A new synthetic, chlorinated isopol, available in metal primer formulations and in powder form, which is practically identical to chlorinated rubber in flame resistance, moisture resistance, chemical resistance, solubility, stability and compatibility with plasticizers, is announced by the *Union Bay State Chemical Co.*, 50 Harvard St., Cambridge 42, Mass.

It can serve as a primer for rubber-to-metal adhesion; as an ingredient in adhesives, paints, lacquers, inks, etc.; as an acid and alkali-resistant coating for metal, concrete and other surfaces; for fire-proofing and/or moisture-proofing fabrics and other materials; wherever sound and heat insulation qualities are desired; and as a plastic wherever inertness to chemicals and fire-proofness are of importance. Chlorinated isopol is the outgrowth of a completely original synthetic rubber formulation developed in the UBS laboratories.

Not yet standardized in viscosity range, production is sufficient to enable sampling and service of reasonably sized orders, but large orders cannot be filled until expanded production facilities are in operation.

The inspector is seated comfortably before the fluoroscopic window of the Picker Ray-Proof Combination X-Ray Inspection Unit. The Unit requires no manual unloading, since ejection of defective parts is automatic.





fluoroscopy or radiography?

The many benefits of x-ray inspection of parts *before* machining have been amply demonstrated in hundreds of case histories where lower costs and higher quality are the end results. The question then resolves itself in one of *method*. Within its limitations, x-ray fluoroscopy is the ideal answer in some cases; radiography is indicated in others. The determining factors are density and section thickness of the material to be examined.

This Picker Combination Conveyor Production Inspection Unit is designed to perform both fluoroscopy and radiography with equal facility. This single Combination Unit obviates the previous need for a separate apparatus for either function.

A Picker engineer will be glad to survey your own inspection problems and recommend a practical procedure, based on your individual requirements. The Picker line of industrial x-ray inspection units embraces types designed not only for large quantity production inspection requirements, but also for small-scale examination where major investment is neither necessary or desirable.

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We are interested in the inspection of: _____

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(This coupon can only cover the highlights of your inspection problem. If you wish to describe it more fully in a letter, it will help us in preparing a recommendation.)

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Constantly tested, constantly improved—Chicago Wheels produce finishes so perfect they pass exacting surface analyzer tests, so accurate they can be measured in micro inches.

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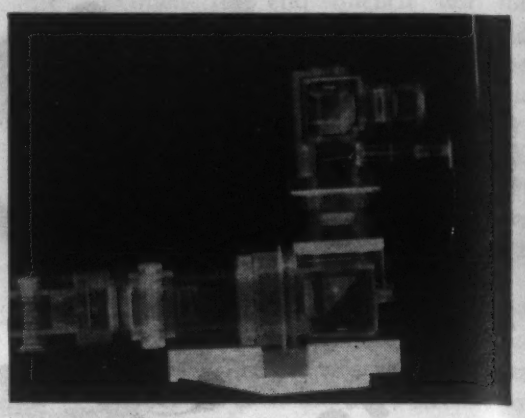
Two Million-Volt X-Ray Unit

X-ray pictures can be taken through pieces of steel a foot thick with a new 2,000,000-volt mobile X-ray unit developed in the research laboratory of the *General Electric Co.*, Schenectady. This doubles the voltage of X-rays available to industry for examination of metal sections for defects.

In radiographing an 8-in. steel casting,



this new outfit is 78 times as fast as the million volt. According to Dr. Ernest E. Charlton, 4½ hr. were required in one set-up to make an exposure through 8 in. with one million volts; only 3½ min. was needed with the two million-volt apparatus.

The new machine makes a good exposure through a foot of steel in 2 hr. when type A X-ray film is used at 3 ft. from the tube end. Such a thickness is practically opaque to million-volt X-rays. Though the new machine weighs 5000 lb., it is mobile in the sense that it can readily be moved by crane and positioned at any angle by push button control of the fractional horsepower motors.

Like the million-volt X-ray, the new apparatus makes use of a multiple-electrode tube, in which the electrons, starting from a heated filament at the top, are speeded in stages until they have the total rated energy. After they attain full speed, which for two million volts is about 179,000 mi. per sec. or 96% of the velocity of light, they strike a copper-backed tungsten target at the end of the tube and X-rays are generated. These may be squirted from the end, like water from a hose, or sprayed from the side. After penetrating the metal specimen, they fall on photographic film, which makes the radiograph.

In the million-volt outfit the electrons, on their way to the target, were speeded in 12 steps, but the new tube has 24, averaging 83,500 volts at each stage. In the tube, rings of fernico are used between the sections of glass, being an alloy that expands with heat the same as glass—hence, the metal and glass can be fused directly together.

High voltage is supplied by a resonance transformer, having no iron core and with the X-ray tube placed at its axis. Both tube and transformer are in the closed metal tank, 5 ft. in diam. and 8 ft. long, containing Freon gas for insulation.

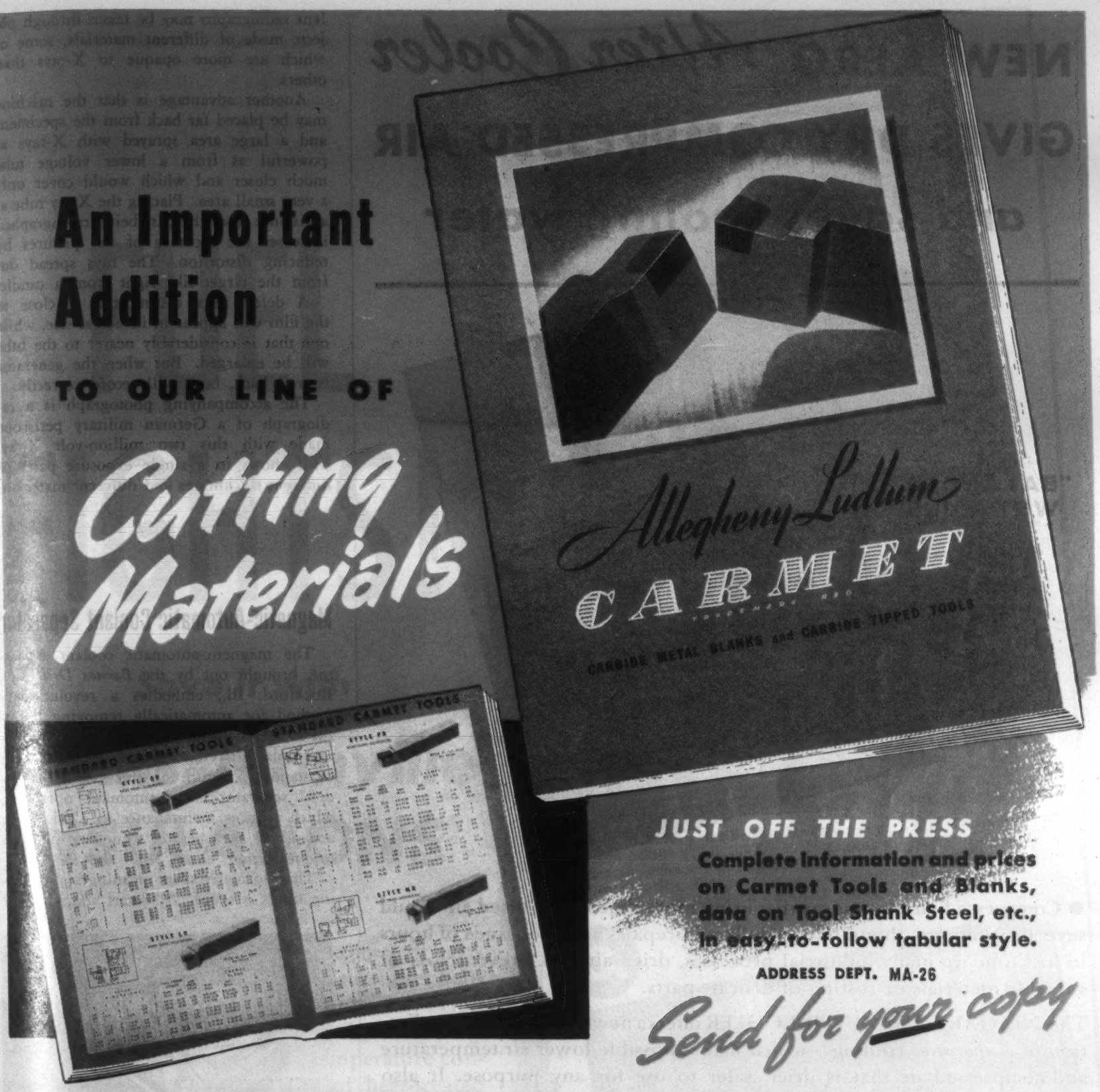
The two million-volt X-ray is advantageous for thinner sections, the usual lead blocks to build up thin sections being unnecessary. Even though the rays are able to penetrate very thick specimens, they will still not over-expose thin sections. Excel-

(Continued on page 1730)

An Important Addition

TO OUR LINE OF

Cutting Materials



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OUR research work has always been strongly identified with cutting materials. With the various high-tungsten types of High Speed Steels as the starting point, followed by the development of the "moly" types, Allegheny Ludlum technicians later originated the patented DBL low-tungsten analysis of High Speed Steel, which has played a major role in wartime tungsten conservation.

Years earlier, our Laboratories did much basic development work on carbides, when they were first introduced in this country. At that time, we registered the trademark "Carmet." Now, with the re-establishment of our Carbide Manufacturing Division, an advanced and complete line of Carmet carbide-tipped tools and carbide metal blanks is available, thoroughly researched and effectively enhancing Allegheny Ludlum's service to users of cutting materials. We invite your attention and inquiries.

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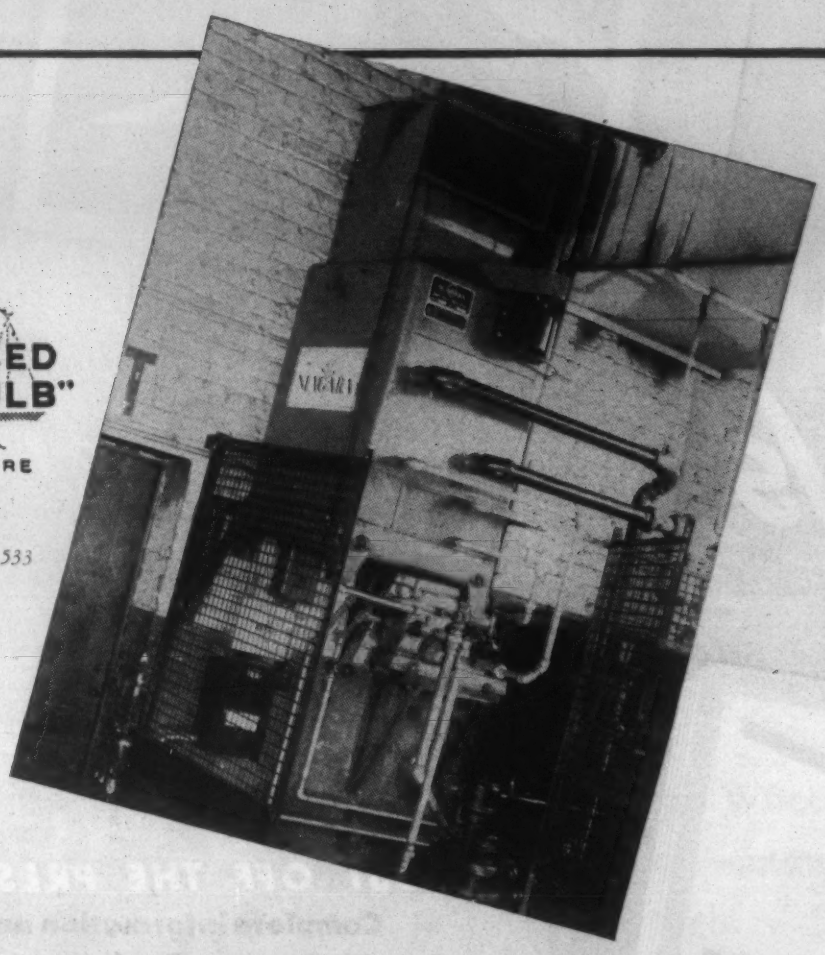
NEW AERO *After Cooler* GIVES DRY COMPRESSED AIR

and saves cooling water



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TEMPERATURE CONTROL
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● Compressed air experts say that using more thoroughly dried air would save air tool users thousands of dollars in repairs and thousands of hours in lost time. In many industrial processes, drier air will prevent loss of valuable materials or rusting of delicate parts.

The NIAGARA Aero AFTER-COOLER offers a new method—the application of *evaporative* cooling—which makes possible lower air temperature and compressed air that is drier, safer to use for any purpose. It also provides closed circuit jacket water cooling with the Niagara "Balanced Wet Bulb" temperature control, preventing condensation and the washing of lubricating oil into the air lines.

In operation, it saves 95% of cooling water consumption, paying for itself in saving water cost. Write for Bulletin 98.

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lent radiographs may be taken through objects made of different materials, some of which are more opaque to X-rays than others.

Another advantage is that the machine may be placed far back from the specimens and a large area sprayed with X-rays as powerful as from a lower voltage tube much closer and which would cover only a very small area. Placing the X-ray tube at a distance from the part being radiographed increases the accuracy of the pictures by reducing distortion. The rays spread out from the target like light from a candle.

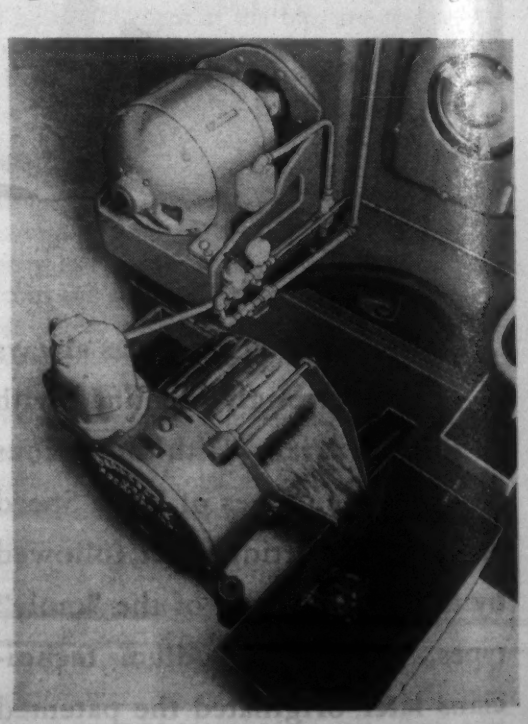
A defect in a casting that is close to the film will appear in its actual size, while one that is considerably nearer to the tube will be enlarged. But when the generator is well back, both will record correctly.

The accompanying photograph is a radiograph of a German military periscope made with this two million-volt X-ray. This shows in a single exposure parts of different thicknesses and different materials.

Magnetic-Automatic Coolant Separator

The magnetic-automatic coolant separator, brought out by the *Barnes Drill Co.*, Rockford, Ill., embodies a revolutionary method for automatically removing harmful metal and abrasive particles from honing coolants having a non-soluble base. The outstanding feature of this new "Barnesdril" separator is its automatic operation, which reduces maintenance to a minimum and allows the operator to devote full time to production.

Time formerly spent cleaning and changing filters is saved. All swarf and magnetic



particles are automatically removed through magnetic attraction. Continuous or intermittent operation is easily achieved.

It is a self-contained, motor driven unit, employing a magnetic rotary drum, which attracts metallic particles as they pass through the coolant and carries them out as the drum rotates. The drum is con-

(Continued on page 1732)

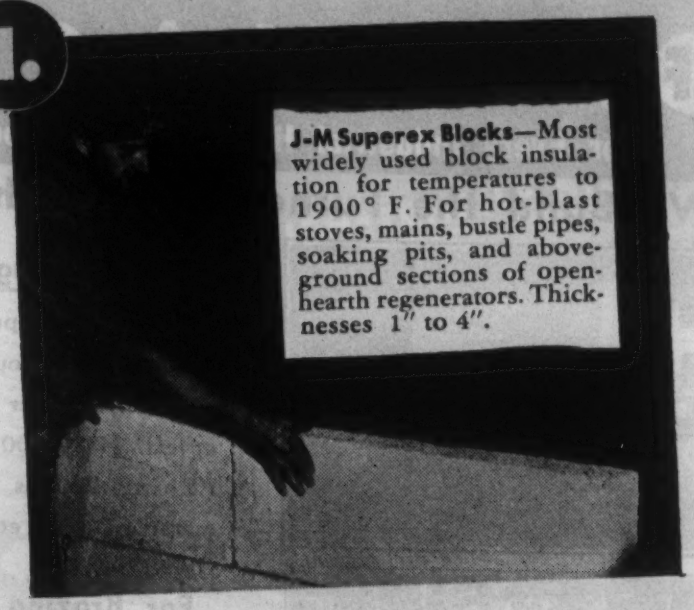
FUEL FIGHTS!

Save it with Johns-Manville INSULATIONS

IN addition to saving fuel, these efficient heat-retarding Johns-Manville Insulations help you in other ways, too. For example, they bring about more uniform heat distribution. They make possible more accurate temperature control. In this way the quality of heat-treated products is materially improved.

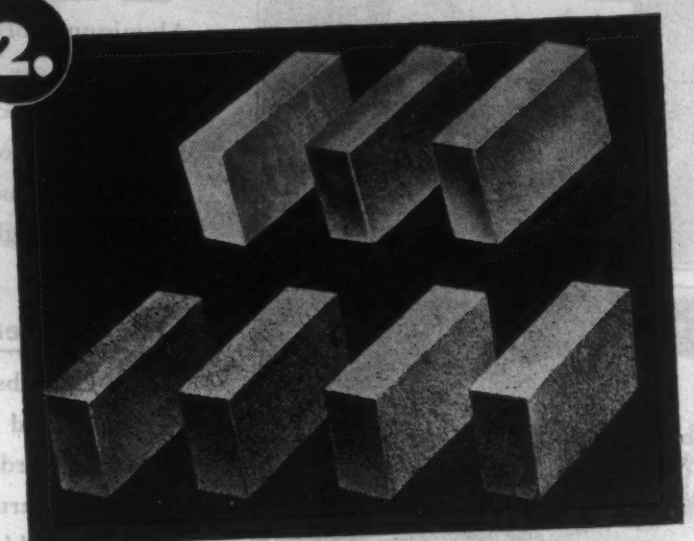
Every insulating requirement of the iron and steel industry can be efficiently and economically filled with one or more of the many J-M Insulations. At right are three widely used items from the complete J-M line. It will pay to use them wherever possible. For more information write: Johns-Manville, 22 East 40th Street, New York 16, N. Y.

1.



J-M Superex Blocks—Most widely used block insulation for temperatures to 1900° F. For hot-blast stoves, mains, bustle pipes, soaking pits, and above-ground sections of open-hearth regenerators. Thicknesses 1" to 4".

2.



J-M Insulating Fire Brick—Seven types with limits ranging from 1600° F. to 2600° F. Uses include bases of open-hearth furnaces, slag pockets and uptakes, reheating and heat-treating furnaces, upper rings of hot-blast stoves. Furnished in standard fire-brick sizes, shapes.

3.

New Insulating Fireblok—To speed application and thus save many hours' down time, J-M makes available four new Insulating Fireblok. This insulation differs from Insulating Fire Brick only in size, being about 5 times larger.

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Johns-Manville
INDUSTRIAL INSULATIONS
FOR EVERY TEMPERATURE . . . FOR EVERY SERVICE

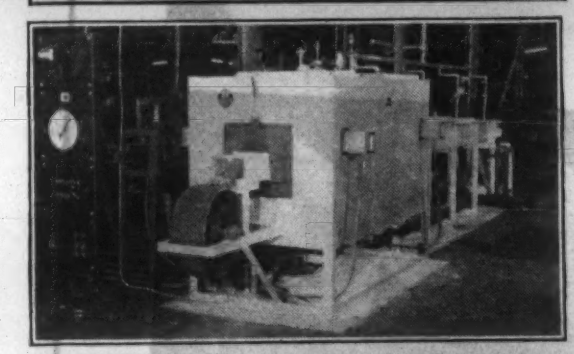
EF FURNACES

For Every Industrial Heat Treating Process

We Build the Furnace to Fit the Job

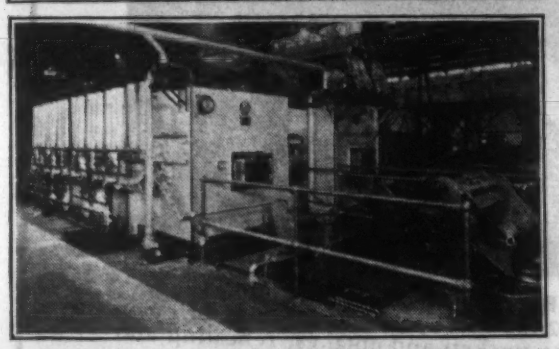
For Sintering Powder Parts

Pressed metal powder products are sintered continuously in the EF special atmosphere roller hearth furnace shown at left. Heats 800 lbs. per hour. Other EF installations are fusing powder metal on strip, etc.



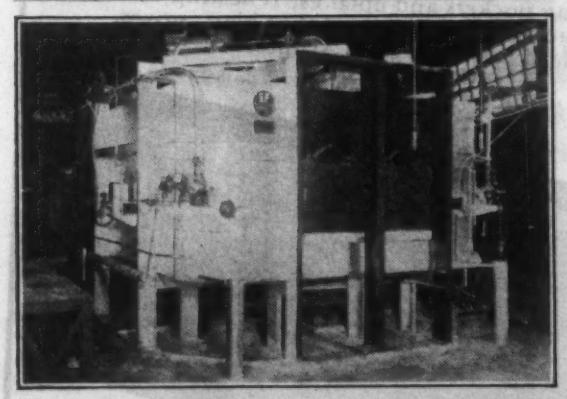
For Brazing and Soldering

Aluminum, brass, copper and steel assemblies are being joined in EF continuous and batch type furnaces. Strong leak-proof joints are made and the complete assemblies are discharged clean and bright. Send for circulars.



For Hardening Small Parts

175 to 2000 lbs. of small and medium size parts and products per hour are scale free hardened in EF continuous chain belt furnaces such as shown at left. We build them either electrically heated or fuel fired. Send for circulars.



Rotary Hearth Furnaces

Various sizes and types for heating large billets for rolling, extruding, etc.; heating for forging, and various other heating and heat treating processes. We build them fuel fired or electrically heated. We solicit your inquiries.

Submit your production furnace problems to EF engineer.

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Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

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For Every Heating and Heat Treating Process

Aluminum Brazing	Carburizing	Nitriding
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We Build the Furnace to Fit Your Job

THE ELECTRIC FURNACE CO.

SALEM, OHIO

structed of a series of permanent magnets mounted all the way around the inside and rotating with it.

The coolant flows rapidly in a thin wide channel through the lower part of the separator in a counter direction to the slow rotation of the drum; the metal and abrasive particles form on the drum and extend on end in a definite brush-like pattern. Then, as the drum rotates, the entire sludge mass is scraped off and discharged through a chute into a movable pan. Constant swarf removal maintains reservoir storage.

There is no temperature rise, and the coolant returns to the reservoir into the base of the machine, ready for immediate recycling. This cycle is entirely automatic and assures efficient, carefree operation. Cleaned coolant results in a higher degree of finish.

Where gravity feed of the coolant from the machine to the separator is impracticable, a motor driven pump may be used for transferring the used coolant into the separator. After the coolant is cleansed, it is carried by gravitation from the separator into the cleaned coolant reservoir.

● A Government regulation limits deliveries of sodium cyanide for heat treating to 1000 lb. per mo., unless special allocations are obtained from Washington. Accordingly, *G. S. Rogers & Co.*, 228 N. La Salle St., Chicago 1, has developed a Specification No. 33 casing salt to replace the cyanide for heat treating. Faster penetrating of the steel, time cycle reductions, a better case structure and easier cleaning are claimed. It provides case depth up to 0.009 in., and is desirable for thin steel sections.

New Hole Punching System

A new hole punching system is the latest addition to the line of the *Wales-Strippit Corp.*, 345 Payne Ave., N. Tonawanda, N. Y. The system reduces perforating die-making to a quick assembly operation that produces many subsequent time-saving, money-saving advantages. By using this system, experienced die makers and die setters are released to work on more complicated dies.

This system consists of "CD" hole punching units, templates, locator rings, adjustable stops, feed rails and drill templets. The system eliminates making special punches and punch plates, making special stripper plates and special die buttons and die plates. Moreover, die design and die making are simplified, and the punches, dies and stripping mechanisms are standardized by being component parts of the units.

The same group of units may be used and re-used in an unlimited number of set-ups, permitting the investment in units to be kept in productive operation rather than in "dead storage." All parts are rapidly interchangeable. Punches and dies are easily removed for sharpening without disturbing the set-up.

Automobile bumpers, cold-formed from N-A-X HIGH-TENSILE STEEL, illustrate the ability of this fine alloy to take the stresses of a critical cold-stamping operation. Result: a tougher, more satisfactory product at reduced fabricating costs.

THIS HIGH-TENSILE STEEL "TAKES OVER" WHERE DRAWING STRESSES ARE TOUGH

N-A-X HIGH-TENSILE STEEL has stepped into some tough spots in the production of intricate shapes. It has proved to production men that here is a great steel to work with, from the standpoints of both manufacturing operations and finished performance.

To put it in a few words, N-A-X HIGH-TENSILE STEEL has what it takes to make a stronger, tougher product through more efficient production methods. Its exceptional ductility and resistance to impact, inherent in the fine grain structure of a great alloy, often make possible the speed and economy of cold-forming on pieces which must be worked hot when other grades of steels are used. And where critical drawing stresses require hot work, N-A-X HIGH-TENSILE STEEL provides the important advantage of maintaining its high physical properties with minimum cooling distortion even after it has been subjected to a wide range of temperatures. No subsequent treatment is needed to maintain "as rolled" specifications.

Add to these advantages the high fatigue life and resistance to corrosion and abrasion that qualify N-A-X HIGH-TENSILE STEEL for varied types of applications, and you'll see why this fine-grain, low-alloy steel is a factor in postwar planning. Great Lakes Steel metallurgical service is yours on request: Let's have your problem.

GREAT LAKES STEEL
Corporation

DETROIT 18, MICHIGAN • SALES OFFICES IN PRINCIPAL CITIES
Division of NATIONAL STEEL CORPORATION. Executive Offices, Pittsburgh, Pa.

HIGHLIGHTS OF N-A-X ALLOY STEEL

N-A-X HIGH-TENSILE STEEL compares favorably with other low-alloy high-tensile steels in yield and tensile strength, with outstanding ductility and notched bar values. In applications where it replaces mild-carbon steels, it serves to reduce weight or increase strength through the utilization of these properties in design.

Another property that may interest you is the excellent weldability of N-A-X HIGH-TENSILE STEEL—whether welded to itself or to other high-tensile or structural steels of welding quality.

N-A-X 9100 SERIES STEELS are produced in carburizing and constructional grades. Except for carbon, they have a chemical analysis that is constant within definite ranges. Together with X-9100 Series steels, containing molybdenum, they provide hardenability ratings to cover a wide variety of requirements, yet give an all-purpose analysis to yield properties. Molybdenum confers great depth hardenability to extend the usefulness of the N-A-X 9100 Series, which are medium-hardening steels.

N-A-X ARMORPLATE is an example of the exacting requirements that Great Lakes can meet with this low-alloy series. One of the X-9100 Series steels is the basis of the armor we produce for tanks, armored cars and practically all landing craft.

Phillips Petroleum Company takes great pride in the unexcelled production facilities that have provided Liquefied Petroleum Gas users with a full measure of service despite the exigencies of war. Thoroughly experienced Philgas engineers are now ready to study your industrial heating problems and give you reliable, specific recommendations as to how LPG will economically benefit your future program. We invite you to contact our nearest Philgas branch office.

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PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

Branch Offices in NEW YORK, CHICAGO, PHILADELPHIA, DETROIT, ST. LOUIS, MILWAUKEE, SHREVEPORT, LA., AMARILLO, TEX., HIBBING, MINN.

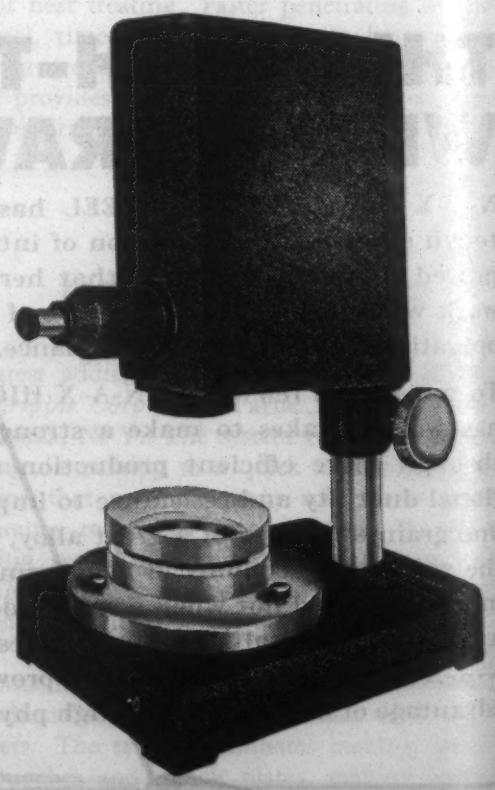
The World's Largest Marketer of Liquefied Petroleum Gas

● "Callo" is a new anti-rust product that seals metals against rust by penetrating the pores of the metal. The maker, *Rust Seal Corp.*, 61 W. 35th St., New York 1, claims that it is non-evaporative, non-combustible, non-drying and transparent. It can be applied by any convenient method, hot or cold.

Device for Measuring Parallelism

A new instrument for measuring the parallelism of seal rings and similar objects, and to determine the change of parallelism under any desired pressure, has recently been announced by the *Scientific Div., Acme Industrial Co.*, 200 N. Laflin St., Chicago 7. It is sold as Acme Lightwave Parascope.

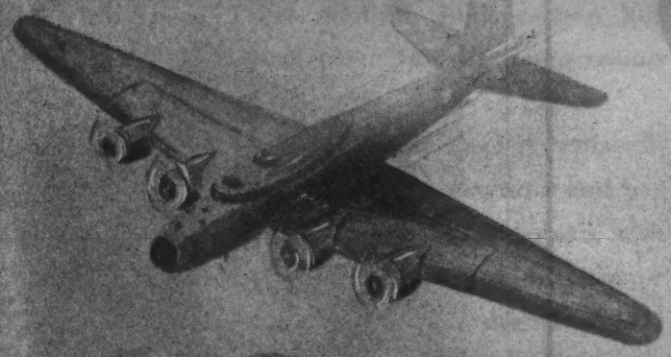
It will also measure the comparative heights of objects, such as balls for precision bearings, all of which must be the same size within a few millionths. To measure parallelism, the work is laid on an optical flat with another optical flat on top. The assembly is then set on the table of the instrument. Looking into the eyepiece, the operator will see a number of bright and dark bands. Each band indicates a change of separation of the optical flat surfaces of approximately 10 millionths of an inch. The operator need only count the number of dark or light bands and multiply by 10 to determine the out-of-parallelism in millionths.

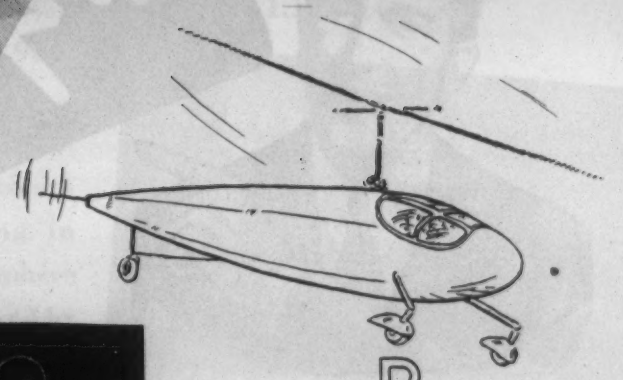


The instrument can also make the usual light-wave check for flatness, where the bands which appear will be straight if the surface is flat, or will be curved to show any deviations from flatness.

The instrument will measure work up to 6 in. in diam. and ½-in. thick. Other sizes and greater thicknesses can be accommodated by special arrangement. It comes complete with built-in light source and transformer for operation on 110 to 120 v., 60 cycle a.c.

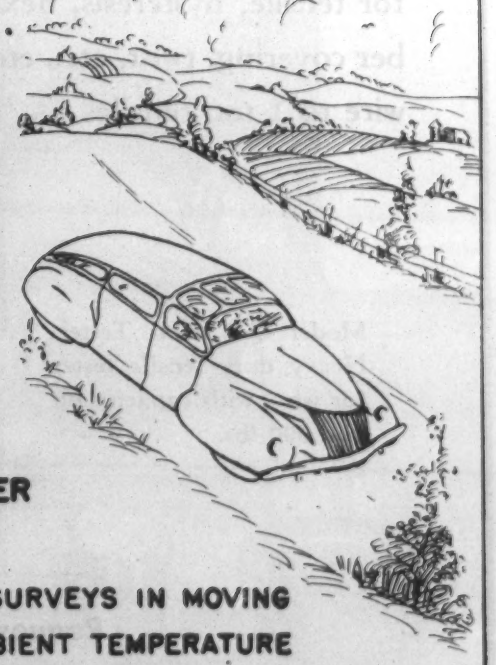
-without a shadow of doubt





WAR

PEACE



THE PORTABLE PYROMETER POTENTIOMETER

THAT WAS DESIGNED AND SERVED IN MAKING TEMPERATURE SURVEYS IN MOVING VEHICLES UNDER CONDITIONS OF VIBRATION AND EXTREME AMBIENT TEMPERATURE BEFORE THE WAR IS SERVING UNDER CONDITIONS OF GREATER VIBRATION AND MORE EXTREME AMBIENT TEMPERATURE NOW, AND WILL BE BETTER ABLE TO MEET THE NEW PEACE TIME REQUIREMENTS OF THE FUTURE.

THE LEWIS ENGINEERING CO.

Specialists in Engine Temperature Measurements

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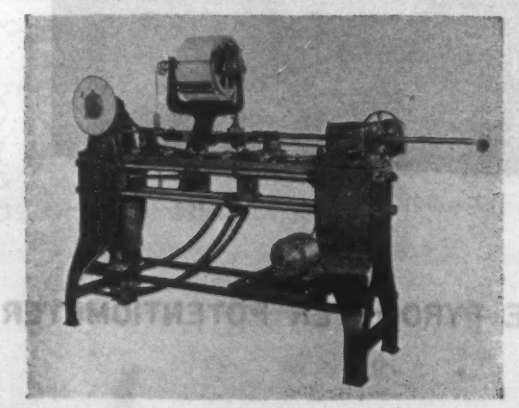
• POTENTIOMETERS • • • • • • SELECTOR SWITCHES • • • • • • • • • THERMOCOUPLES •
• PYROMETERS • • • • • • RESISTANCE THERMOMETERS • • • PROTECTION TUBES •

Utilize the full benefits of *Scott Testers

An adequate testing routine contributes to smooth operation in four distinct ways: by speeding research, facilitating purchasing, promoting production and proving quality. Our 60 models cover the needs of wire and strip testing for tensile, hysteresis, flexing, compression-cutting of rubber covering, twist, etc., etc. Capacities from finest filament wire to 1 ton tensile.



Model Q-7 Scott Tester. Heavy duty tensile tester for wire, with capacity up to 2,000 lbs.

Request Circulars

HENRY L. SCOTT CO.

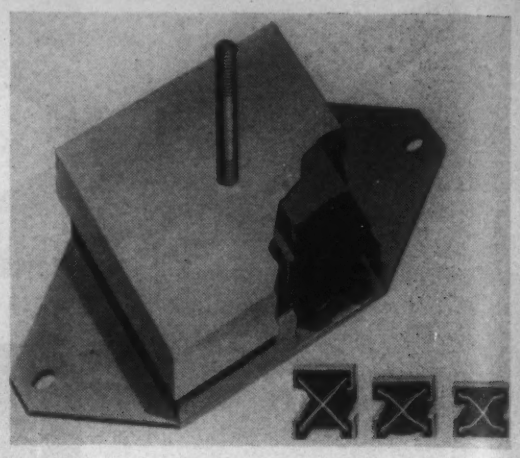
65 Blackstone St. **SCOTT TESTERS** **Providence, R. I.**

***Registered Trademark**

Scott Testers — Standard of the World

Mounts to Cure Vibration and Noise

Rexon, a radically new type of vibration mount, characterized by extreme simplicity in design and application, and by virtual indestructibility in use, has just been announced by *Hamilton Kent Mfg. Co.*, a unit of U. S. Stoneware Co., Akron, Ohio.



Determination of the proper type of Rexon mount and its actual installation requires neither engineering skill nor alteration of equipment. Only two standard types of mountings are required to effectively isolate all kinds of vibration.

All that an engineer need know is the total weight, the weight distribution of the machine to be insulated, and whether the direction of the vibration is vertical or horizontal. Loading is not critical—a tolerance of plus or minus 10% in computing machine weight or weight distribution is permissible.

Rexon utilizes the time-proven vibration dampening properties of rubber in shear, but with no possibility of overloading the shear elements. This unique property stems from the use of a special "X" type design of the rubber element, which acts in shear at the points of the "X" under normal loading, but in compression when the load exceeds the rated capacity of the mount.

Rexon mounts cannot be damaged by temporary or permanent overload. No rubber-to-metal bonds, either mechanical or chemical are used. Independent laboratory tests have established the fact that Rexon mounts have almost double the deflection for a given load when compared against standards previously recorded. The internal dampening characteristics of these mounts virtually eliminate any problem of resonance, as they have no critical frequency points.

The mounts can be easily and quickly installed without use of special angles, brackets or radius rods, and without increasing the overall height of the machine more than 1½ to 2 in.

The three small inset photographs show the action of the mount at rest, under normal load and when overloaded.

● A new alloy to save the more common nickel-chromium alloy for electrical resistance in electrical instruments has been patented by *Theobald H. Noll*, Washington, according to the *N. Y. World-Telegram*. In the alloy are 4% nickel, 14.3% chromium, 2.6% aluminum and the rest iron.

66% Saved on Production Cost Using *Speed Treat Plate* and Simple Heat-Treatment!

A large plastics molding firm replaced high alloy steel with *Speed Treat* medium high carbon hot rolled open hearth steel plate for the compression mold die shown.

Costing *less than a third* of the steel it replaced, *Speed Treat Steel* proved easier to machine and has turned out over one-half million molded parts with no appreciable wear and no signs of fatigue or breakage in the inside walls of the die which are only .350″ thick. In operation, a pressure of 60-tons is exerted on the mold.

Size and weight of the mold were also reduced—an important factor since it is handled by women.

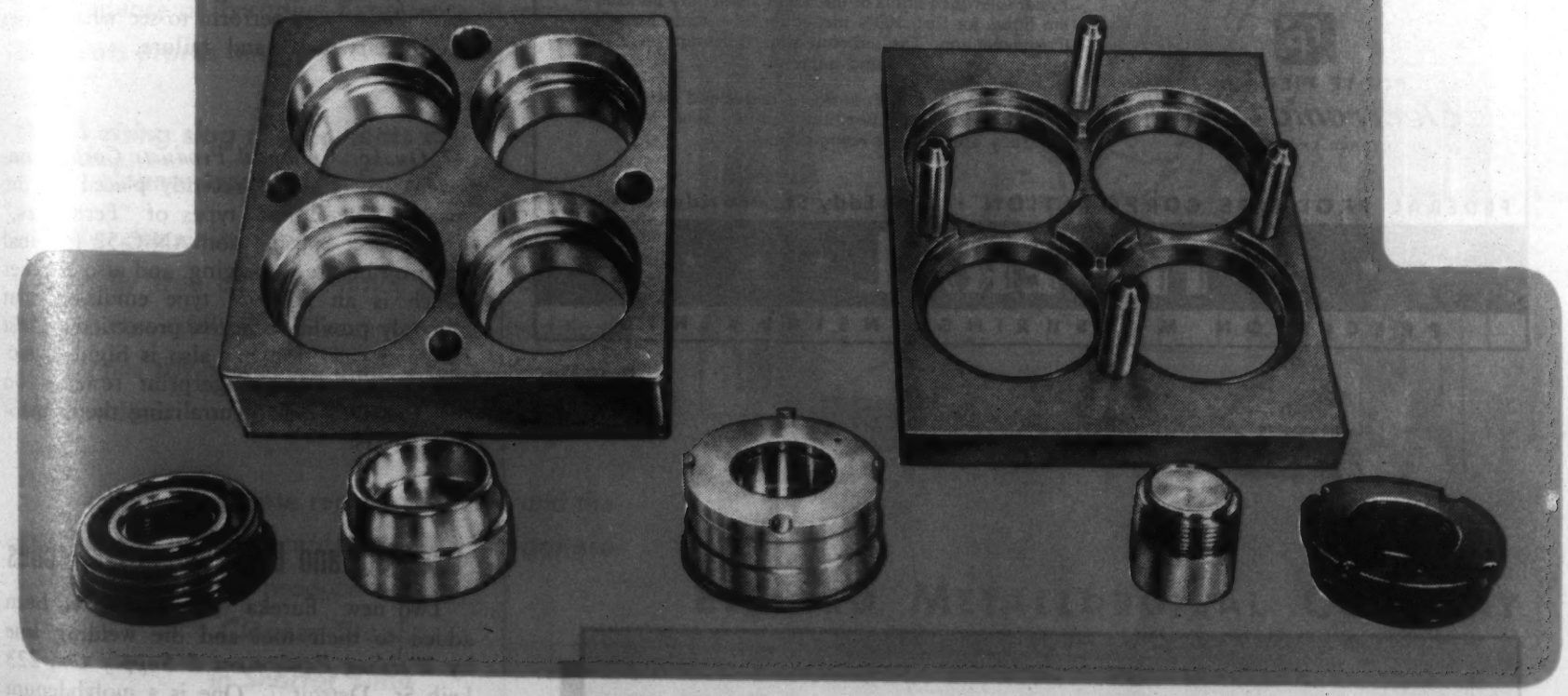
Auniform case 1/16″ deep was developed by pack carburizing. Starting with a carbon content of 0.49%, drillings showed the case had an average carbon content of 1%, varying from 1.13% on the surface down to .95% at a depth of 1/16″.

After carburizing, hardening was accomplished by heating in controlled atmosphere to 1500° F., followed by an oil quench. A test showed a surface hardness of 62 Rockwell "C" had been developed.

SPEED TREAT Plate Provides.....

- Better Finish
- Lower Machining and Tooling Cost
- Ideal Response to Heat Treatment
- Negligible Heat Treat Distortion
- Reduced Weight
- As Much As 66% Lower Material Cost
- Savings in Production Time
- Lowest Ultimate Cost

The high surface hardness, exceptional tensional strength and body toughness so readily produced with the simple heat treating procedure outlined renders this unusual steel practical for use where high carbon steels and other costlier steels were formerly thought necessary. The economical advantages of *Speed Treat* warrant its consideration for your postwar dies, shoes and molds; wear, surface and bolster plates; gears and sprockets, machine ways and numerous other parts, many of which are pictured in Catalog 1243, sent on request.



W. J. HOLLIDAY & CO.
Speed Case-Speed Treat Plate Division
Hammond, Indiana
"Established 1856"
PLANTS: HAMMOND AND INDIANAPOLIS, INDIANA

OBTAINABLE AFTER DEC. 1ST
Peninsular Steel Co., 1030-40 McDougall Ave., Detroit.
Earle M. Jorgensen Co., 5311 Clinton Drive, Houston.
10510 So. Alameda St., Los Angeles 54, Calif.
1657 22nd St., Oakland 7, Calif.
Grammer, Dempsey & Hudson, Inc., Newark, New Jersey

Quality Controlled Speed Case and Speed Treat Steel Is Available In All Common Plate Sizes from these Distributors

Benis, McCarthy & Rogers, Inc.
Buffalo, New York

The Burger Iron Company
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Brown-Wales Company
493 C. Street, Boston, Mass.

Horace T. Potts Company
East Erie Ave. & D St., Philadelphia. Pa.

Peckover's Limited, 77 Front Street, E., Toronto, Ont., Canada

NOW FEDERAL brings you

more CONVENIENT and SENSITIVE

GAGING by ELECTRONICS

ONE-PASS INSPECTION

Workpiece is passed *directly* under contact. No stopping and no backstop required. 30 to 60% faster inspection, accurately

MODEL 130

OUTSTANDING BECAUSE–

Limit lights show immediately any variation in specified dimension. No hesitation, no backstop, positive.

No maximum and minimum masters required to set dimension limits.

Unusual wide-range zero adjustment makes setup simpler, faster and more positive.

Contact pressure adjustable from 2 to 16 ozs.

Four magnifications enable readings from ten microinch to .003". Even finer readings can be estimated.

This Comparator is of great value for fast, 100% inspection at either Production or Final Inspection. The speed is unusual. There is no necessity for slowly maneuvering the workpiece under the sensitive contact to determine its maximum dimension, nor to bring it to rest against a backstop. Actual time studies indicate savings in inspection time of from 40% to 60%.

Either tolerance lights or the meter scale may be used—the lights for fast, 100% inspection; the scale for selective inspection. The indicating hand swings positively and stops definitely and quickly.

This exceptional Comparator is a decided advance in gaging devices. Its flexibility, range, sensitivity and accuracy are worth investigation.

FOOTE PIERSON
Electronic Gage
MANUFACTURED EXCLUSIVELY FOR

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PRECISION MEASURING INSTRUMENTS

DIAL INDICATOR TRUISM—

Feeling a measurement is **Relative**

— Seeing it is **Exact.**

★ FEDERAL ★

High-Speed X-Ray Photographs

High-speed X-ray photographs, taken in a millionth of a second, are adding knowledge to the science of ballistics and will have post-war uses such as studying the rapid metallurgical changes during arc welding, inspecting metal parts on a speedy conveyor belt, and studying the flow of dirt through a vacuum cleaner, states Dr. Charles M. Slack, *Westinghouse Electric & Mfg. Co.*, East Pittsburgh, Pa.

Such photographs show that a high explosive shell inflates to twice its normal diameter before it appears to burst and that the blast accompanying the firing of a rifle bullet sometimes reaches the muzzle before the bullet does.

The X-ray tube requires a sudden burst of 600,000 kilowatts of electricity to make exposures of a millionth of a sec. The tube draws the electrons out of a cold metal cathode when a high momentary voltage is applied. A vacuum metallic arc is produced through which the electrons stream until they strike the anode, which, in turn, results in a barrage of X-rays through solid metal to make the photographs.

Ultra high-speed X-raying is the only adequate method of determining how a bullet or shell behaves as it hurtles down the bore of a gun or as it strikes a target, according to Dr. Slack. One failed bullet might jam a machine gun. One can observe the realignment that goes on inside a bullet as it zips along the gun's bore, several sequence pictures being made.

For the study of rapidly-moving machine parts we no longer will have to wait until these parts perform to see what causes unnecessary wear and failure.

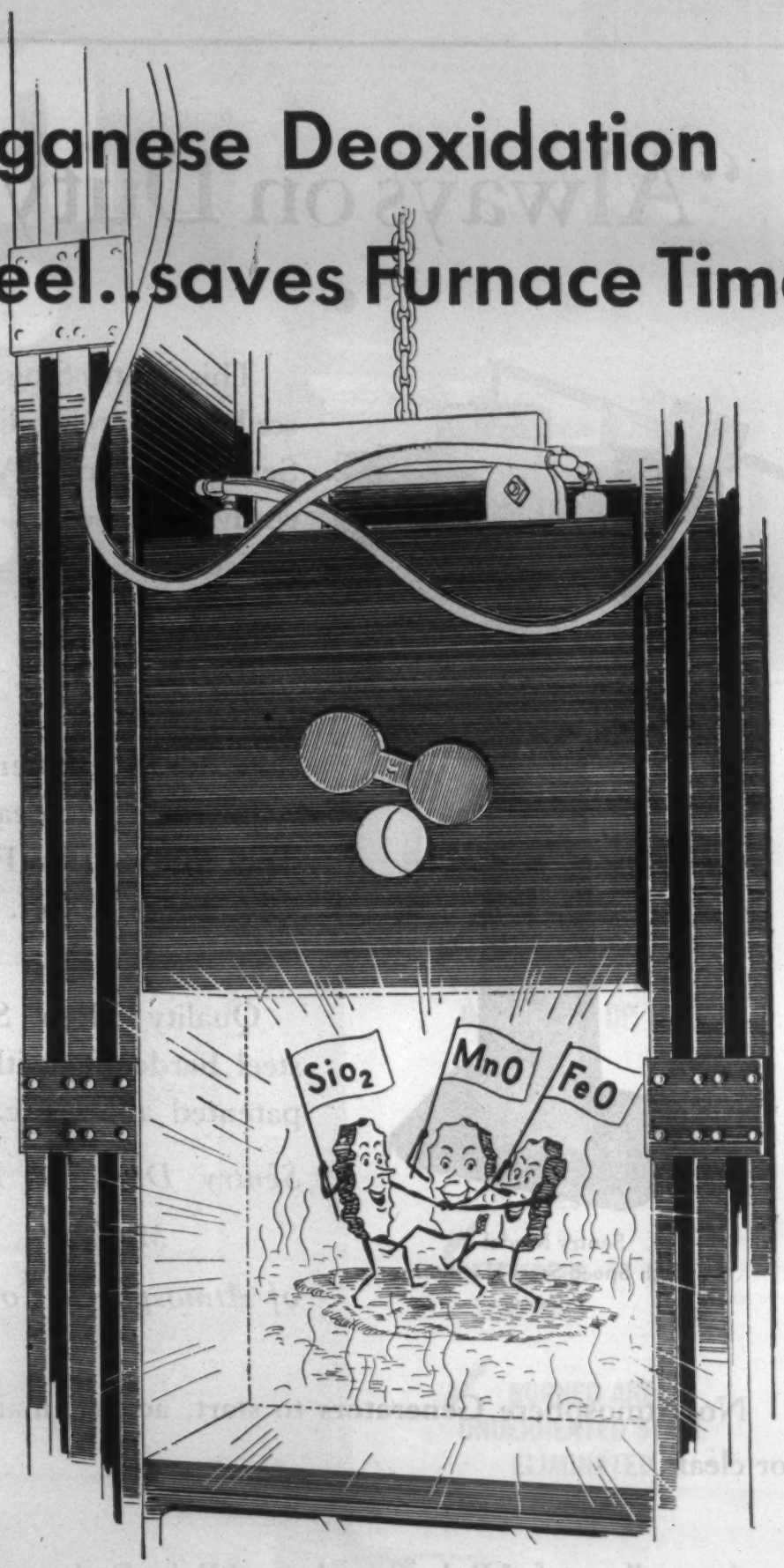
● *Quaker Chemical Products Corp.*, Conshohocken, Pa., has recently placed on the market several new types of "Ferrocotes," which meet Specification AN-C-52 for final slushing before packaging, and also another which is an aqueous type emulsion that not only provides effective protection against rust and corrosion but also is highly effective in dissolving fingerprint residues on metal surfaces and neutralizing their corrosive effects.

Two Tool and Die Welding Electrodes

Two new "Eureka" electrodes have been added to their tool and die welding line by *Welding Equipment & Supply Co.*, 223 Leib St., Detroit 7. One is a molybdenum high-speed steel electrode producing weld deposits at 60 to 64 Rockwell C hardness; the other is a hot work tool steel electrode producing carbon-molybdenum-chromium deposits having Rockwell C hardness of 58 to 62 and abrasion resistance at high heat. Both produce "hard-as-welded" deposits which can be heat-treated if desired.

The Eureka line of tool and die welding electrodes now comprises two water hardening, two oil hardening, one air hardening, two hot working, one high-speed steel and two special alloy electrodes for forging, drawing and forming dies.

Why Silicomanganese Deoxidation produces Clean Steel..saves Furnace Time



Silicomanganese deoxidation produces large slag particles.

Silicomanganese is a combination alloy of the two most commonly used deoxidizers... silicon and manganese. The combination slag containing the three compounds...iron oxide, manganese oxide, and silica...forms larger particles than slags of just two of these compounds together.

Large particles rise more quickly out of the bath than small particles.

The speed with which particles rise in the bath depends on their size. Stokes' Law shows that the speed with which a particle will rise is proportional to the square of its radius. Experience in commercial heats proves this.

Quick-rising slag means heats are cleaner and ready for tapping sooner.

Baths deoxidized with Silicomanganese are practically free of non-metallic matter within a few minutes after the Silicomanganese addition. This means savings of as much as 20 minutes in furnace time.

• • •

Since the manganese recovery is high, and the deoxidation is so complete, Silicomanganese makes it possible to produce

Cleaner Steel
in Shorter Time
at Lower Cost

than by other methods.

Our metallurgists will co-operate with you in the use of Silicomanganese for the best results.

For further information on Silicomanganese, write for the booklet, "*Silicomanganese Alloys for the Deoxidation of Steel.*"

BUY UNITED STATES WAR BONDS AND STAMPS

ELECTRO METALLURGICAL COMPANY
Unit of Union Carbide and Carbon Corporation
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30 East 42nd Street, New York 17, N. Y.
In Canada: Electro Metallurgical Company of Canada, Limited, Welland, Ontario

Electromet
Trade Mark
Ferro-Alloys & Metals

"Always on Duty"

Sentry Model Y
High Speed Steel Hardening
Furnace

This Sentry Slogan describes the reliability of Sentry Furnaces. Always ready for use on short notice.

Rapid heating — 1 hour to 2350°F. Well suited to intermittent use requirements. Ideal for Tool Rooms. No Fumes — Quiet — Clean.

Quality High Speed steel hardening with the patented automatic.

Sentry Diamond Block Method of Atmospheric Control.

No Atmosphere Generators to start, adjust, maintain or clean.

Any alloy of High Speed or High Carbon High Chrome steel hardened rapidly without scale or decarburization. No specially trained or highly skilled operators required. Hardening quality consistently of the highest.

Send sample pieces for demonstration or Write for Bulletin 1020-5C

The Sentry Company
FOXBORO, MASS., U.S.A.

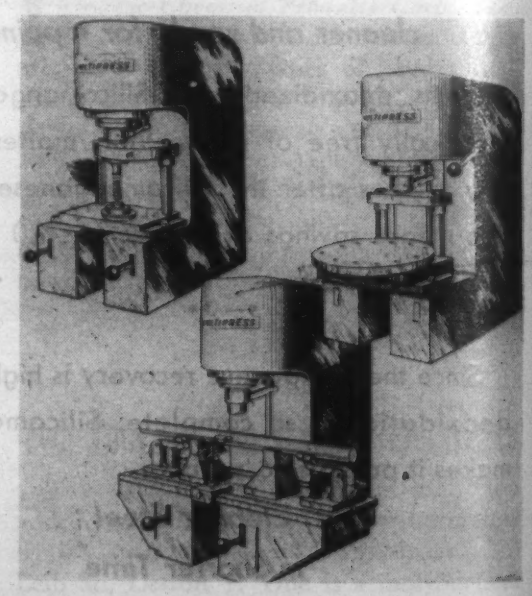
● A flux designed to promote uniformly successful tinning of cast iron prior to brazing, called Airco Hi-Bond, is announced by *Air Reduction Sales Co.*, 60 East 42nd Street, New York 17. It makes possible highly satisfactory tinning of cast iron, especially of high carbon and silicon content or low combined carbon analysis. It does not take the place of the regular flux used for brazing. It is applied as a water-mixed paste or as a powder sprinkled on the surface that has already been heated to the required temperature.

Versatile Oil Hydraulic Press

A new bench machine, providing from 300 to 8,000 lb. pressures in single or repeated up and down strokes, is announced by *Denison Engineering Co.*, Columbus 16, Ohio. Called "Multipress" because it is basically an oil hydraulic press of many uses, it will deliver up to four tons downstroke pressure and up to 5000 lb. "pull up" pressure.

It can utilize a wide variety of fixtures to perform pelleting, honing, broaching, peening, assembling, burnishing and straightening. The machine weighs 745 lb., with dimensions of 16 by 26 by 34 in. Operation is accomplished by depressing the control levers, causing the ram to move downward; releasing either lever, which stops the ram instantly; releasing the other lever, which causes the ram to return to its upper limit, where it is positively held.

By slowly depressing the hand levers the ram can be "inched" downward slowly and positioned exactly above the work before pressure is applied. Full pressure can be



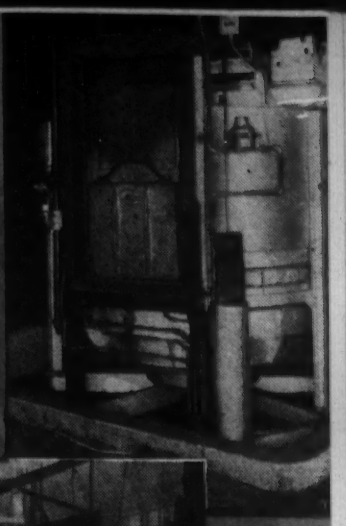
applied instantly by completely depressing the levers at once, or gradually, by depressing the levers slowly.

Prominent among the available accessories is "automatic cycling," in which a single lever affords the operator his choice of four automatic actions. Cycling is achieved entirely by oil hydraulic operation. Bringing the lever to "continuous cycle" position causes the ram to automatically move up and down with precise timing and pre-set length of stroke, exerting the pre-set pressure upon each piece of work being fed to it.

Hagan

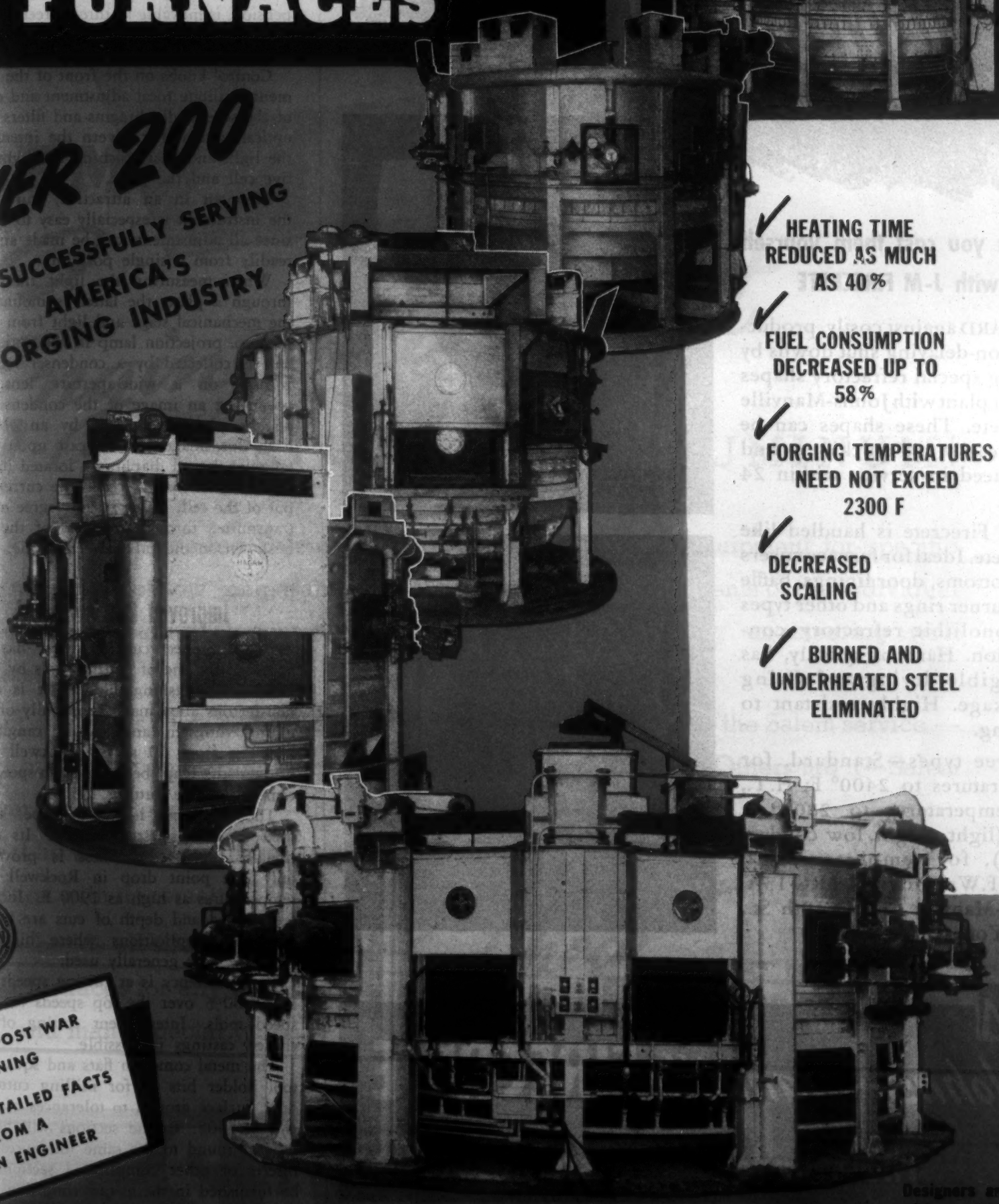
ROTARY HEARTH

FORGING FURNACES



OVER 200

NOW SUCCESSFULLY SERVING AMERICA'S FORGING INDUSTRY



- ✓ HEATING TIME REDUCED AS MUCH AS 40%
- ✓ FUEL CONSUMPTION DECREASED UP TO 58%
- ✓ FORGING TEMPERATURES NEED NOT EXCEED 2300 F
- ✓ DECREASED SCALING
- ✓ BURNED AND UNDERHEATED STEEL ELIMINATED

FOR YOUR POST WAR PLANNING

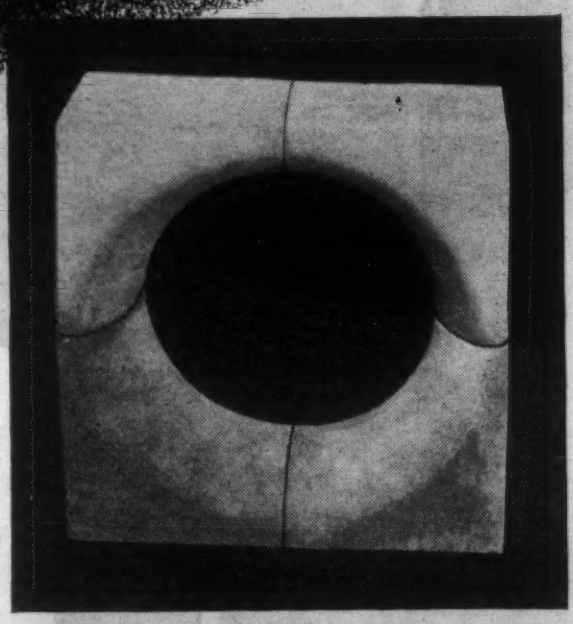
GET THE DETAILED FACTS FROM A HAGAN ENGINEER

GEORGE J. HAGAN COMPANY

PITTSBURGH, PA.

Designers and Builders of Dependable Furnaces and Equipment for every Industrial Heating Need.

SPECIAL REFRACTORY SHAPES - IN SERVICE WITHIN 24 HOURS

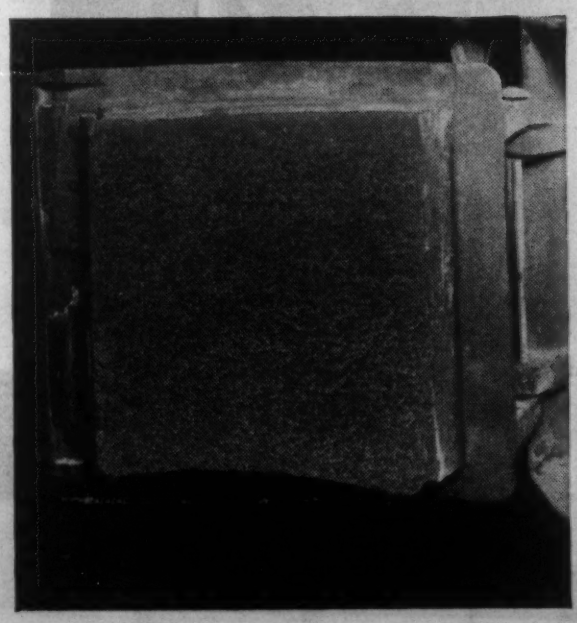


When you cast them yourself with J-M FIRECRETE

GUARD against costly, production-delaying shut downs by casting special refractory shapes in your plant with Johns-Manville Firecrete. These shapes can be made easily and quickly . . . and be placed in service within 24 hours.

J-M Firecrete is handled like concrete. Ideal for furnace covers and bottoms, door linings, baffle tile, burner rings and other types of monolithic refractory construction. Hardens quickly, has negligible drying and firing shrinkage. Highly resistant to spalling.

Three types—Standard, for temperatures to 2400° F; H.T., for temperatures to 2800° F; L.W. (light weight, low conductivity), for temperatures to 2400°F. Write for folder RC-13A. Johns-Manville, 22 E. 40th St., New York 16, N. Y.



JM PRODUCT

Johns-Manville **FIRECRETE**

The Standard in Castables

Photometer for Measuring Light Transmission

A new transmission photometer for measuring accurately the amount of light transmitted through very small areas of spectrographic plates has been announced by the *Special Products Div., General Electric Co.,* Schenectady. It is desirable for use where spectrographic analysis is employed, such as the metal fields, for microcolorimetric and microchemical analyses and for measuring light transmission through solutions.

Requiring a constant power supply of 6 v., a.c. or d.c., with capacity of 30 amp., the photometer consists essentially of a light source, an optical system, a galvanometer, a light-sensitive cell, and a mechanical stage for accommodating the plate. This stage, which has a three-point, ball-bearing suspension, is movable in three directions, thus providing smooth, precise control of the position of the plate.

Control knobs on the front of the instrument facilitate focal adjustment and control of the several diaphragms and filters in the optical system that govern the intensity of the light and heat reaching the light-sensitive cell and the plate.

Mounted in an attractive, sturdy case, the instrument is especially easy to operate, since all adjustments can be made and seen readily from a single position.

When measuring the light transmitted through a plate, the latter is mounted on the mechanical stage and light from a 6-v., 18-amp. projection lamp in the optical system is collected by a condenser lens and focused on a wide-aperture lens, thus producing an image of the condenser lens on the plate. Magnified by an objective lens, this image is then cast upon a rectangular-shaped diaphragm located in front of the light-sensitive cell. The current output of the cell, which is the degree of light transmitted through the field of the plate, is shown on the galvanometer scale.

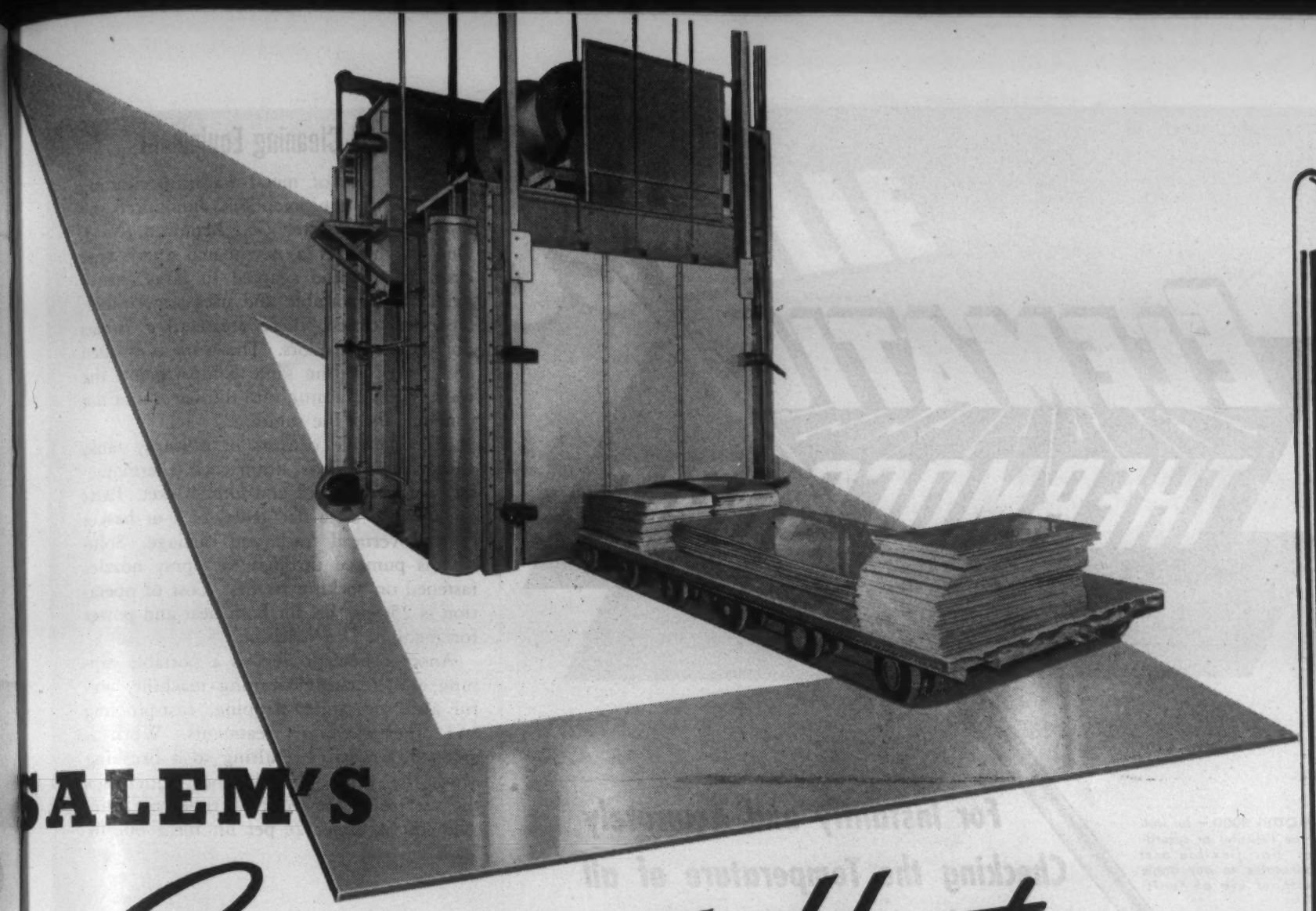
Improved Cutting Metal

An improved cutting metal has been added to its line of cutting tools by *Jessop Steel Co.,* Washington, Pa. It is a cast non-ferrous alloy made principally of chromium, tungsten and cobalt, ranging in hardness from 60 to 62 Rockwell C. It bridges the gap between high-speed and cement carbide cutting tools.

The new tool is cast-to-shape, and is used in the as-cast condition. Its exceptionally high red-hardness is proved by only one point drop in Rockwell C. at temperatures as high as 1900 F. Increased feed, speed and depth of cuts are possible on many applications where high-speed tools are now generally used.

Peak efficiency is at cutting speeds from 20 to 80% over the top speeds for high-speed tools. Intermittent cutting of even chilled castings is possible.

The metal comes in flats and squares for tool holder bits or for milling cutter inserts, surface ground to tolerances of 0.000 and —0.005. Round sections will be centerless ground to the same tolerances. Die inserts or other complicated sections will be furnished in the as-cast condition.



SALEM'S

Engineered Heat

APPLIED TO ALUMINUM!

A customer requested Salem to design a new type of low temperature furnace for heat treating aluminum sheets and plates.

Salem engineers came up with a unique method of convection heating, incorporating several new ideas. Result — the buyer has what he wants . . . uniform, consistent production with no remelting or reheating.

Salem builds all sizes and styles of heat treating furnaces for any fuel: batch, car, rotary, and many special types.

We design the equipment for specific production requirements of the individual customer, combining engineering with economics.

Our engineers call the Salem service — "Engineered Heat." Others tab it—Salem Ingenuity.

Check your 1945 heat treating requirements with Salem. Prompt attention to your heat treating inquiry.

SALEM **SALEM** OHIO

ENGINEERING CO.

SALEM ENGINEERING COMPANY

MODEL 4000 — for wall type indicator or recorder. Has flexible arm adjustable to any angle without use of tools

For Instantly and Accurately Checking the Temperature of all Nonferrous Molten Metals

Everyday, an increasing number of foundries are adopting the more efficient *Elematic Thermocouples*. Not only because they give such dependable temperature control, but because they are more economical.

All Elematic Thermocouples are equipped with our own, exclusive *Metalast Protection Tubes*— long life tubes which can be easily replaced without damaging or discarding the thermocouple, and at a saving of time and labor.

Made of a special heat resisting alloy, in types for both furnace and ladle use, Elematic Thermocouples with Metalast Protection Tubes have been tested and approved by scores of the largest brass and copper foundries in America.

DOUBLE THE LIFE OF YOUR THERMOCOUPLES WITH THIS REPLACEABLE METALAST TUBE

Simple to attach . . . fully protects thermocouple from slag or molten metal . . . drilled from solid special alloy stock without welds or seams. Available in 6″ or 8″ lengths with ½″ pipe thread.

ELEMATIC EQUIPMENT CORP.

6046 WENTWORTH AVENUE, CHICAGO 21, ILLINOIS

Metal Cleaning Equipment

A new line of metal washing, cleaning and drying equipment is announced by *Optimus Equipment Co.*, Matawan, N. J. One of these is a new batch spray type cleaning machine adapted to large, heavy parts. It is portable and uses any cleaner. Operated closed, there are neither fumes nor unpleasant odors. The work is washed and rinsed in the same compartment, the waste water draining into the sewer and not contaminating the solution.

The machine consists of a sturdy tank, with cleaning door, drain cock, thermometer, water inlet cock and filter basket. Parts are lowered on a flat grille, rack or basket by an overhead track and carriage. Solution is pumped through the spray nozzles fastened on rocking frames. Cost of operation is 25c per hr. for both heat and power for medium size machines.

Another new product is a portable dipping and agitating cleaning machine, useful also for paint stripping, rust-proofing and other chemical treatments. Work is agitated vertically, resulting in a brushing action by which the cleaning liquid hits the surface of the work 30 times per min. The cost is under 2c per hr. for a 600-lb. load.

● A ready means for comparing wire test sieves used in European countries and the United States for grading different kinds of finely powdered materials is contained in a new publication called "Comparison of Fine-Series, Square Mesh Wire Test Sieves of Different Countries," by R. E. Brewer. It is obtainable from the *Bureau of Mines*, Department of Interior, Washington, D. C., and is designated "Report of Investigation 37.66."

Light Weight Electrode Holder

A lighter and cheaper holder for welding electrodes is announced by *Lincoln Electric Co.*, Cleveland. With a current rating of 300 amp. and with ample capacity for overload, the new holder will handle various sizes of electrodes from 1/16 to ¼ in. diam.

Jaws are made of high conducting and wear resisting copper alloy, known as "Lincalloy." They are fully guarded from contacting the work by a durable spring

steel insulating guard that is easily replaceable. The trigger is of molded, heat-resisting inorganic material.

Other features are: hollow, air-cooled, heat-resisting fibre handle, excellent balance, and good performance on both a.c. and d.c. current. It holds electrodes securely at any angle yet permits quick and easy change of rods.

Precision

FORGINGS

The ever-increasing demand for Struthers Wells Forgings is due primarily to . . .

- ★ Advanced production methods
- ★ The dependability, durability and product exactness that is possible with master craftsmen
- ★ Unexcelled facilities and broad experience, covering more than fifty years.

It is significant that a recent check among leading equipment manufacturers reveals that "Precision Machined Forgings" are slated for an extremely important role in the new and improved products planned for the post-war period.

Titusville engineers are ready to cooperate anytime, anywhere.

Choose TITUSVILLE
For these very good reasons:

More Than Fifty Years Successful Forging Experience

Three Large Plants, Strategically Located

Complete Forge Shop Presses to 2000 ton capacity

Two Large Welding Shops, Nearly 200 Welding Machines

Three Large Modern Machine and Pattern Shops

Largest Gas-Fired Annealing Furnace of its kind

X-Ray and Laboratory Testing Equipment

Master Craftsmen, skilled in Quality and Quantity Production

SW

STRUTHERS WELLS CORPORATION
TITUSVILLE FORGE DIVISION
PLANTS AT TITUSVILLE, PA. AND WARREN, PA.
Offices in Principal Cities

VITREOSIL

(Vitreous Silica)

Highest temperature shock resistance of any ceramic material!

PIPE

Vitreosil pipe gives outstanding service in chemical, electrical, metallurgical and other technical applications because of its unique resistance to extreme chemical, thermal and electrical conditions. Consisting of a pure homogeneous material, it is nonporous and constant in quality, and will not sweat, crack, or disintegrate superficially. Vitreosil is unaffected by most acids or halogens (regardless of concentration or temperature).

Vitreosil pipe is especially suitable for: conveying and cooling hot acid gases and liquids; reactions at high temperature; sintering; chloridizing; heat treatment; high vacuum and controlled atmosphere techniques. Sizes up to 30″ bore. For details write for Bulletin No. 7.

TUBING

Vitreosil tubing has the same physical characteristics as Vitreosil pipe, but is available in smaller sizes. It is produced in four qualities: Sand Surface, Glazed, Satin Surface, and Transparent. Stocked in diameters from 1/32″ to 4½″ and lengths up to 10 feet; also supplied on special order to customers' specifications. For details write for Bulletin No. 9.

VITREOUS SILICA — VITREOSIL — REG'D TRADE MARK

THE THERMAL SYNDICATE, LTD.

12 EAST 46th STREET, NEW YORK 17, N.Y.

Precipitation Hardening Alloy

A new precipitation hardening alloy having exceptional uniformity in response to heat treatment is announced by the *W. M. Chace Co.*, 1615 Beard Ave., Detroit 9. It has a nominal chemical analysis of 60% Cu, 20% Ni, and 20% Mn, and is designated as No. 720 manganese alloy. It has a silvery color, and presents an attractive surface when polished. It is corrosion resistant, not differing greatly from the familiar cupro-nickels.

The alloy is a soft, ductile metal that can be either hot or cold formed into intricate shapes and then hardened to a remarkable degree by a comparatively low temperature aging treatment. A hardness of 400 Vickers can be readily obtained by aging either dead soft or cold worked material.

The physical properties corresponding to this hardness are: tensile strength, 200,000 p.s.i.; yield stress for 0.1% offset, 170,000 p.s.i.; and a proportional limit of 120,000 p.s.i. High freedom from "drift" and high fatigue strength make the alloy especially useful as a spring material.

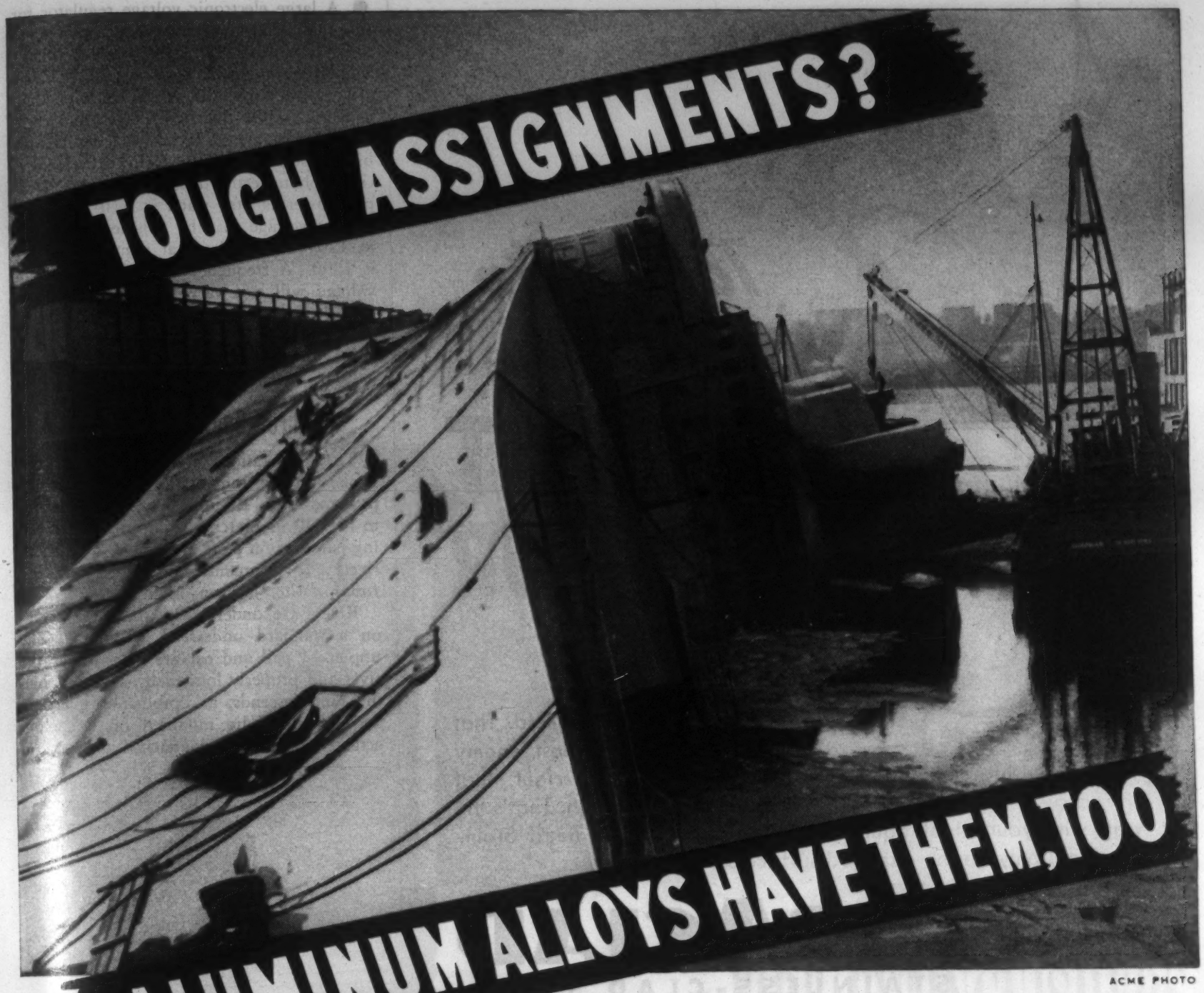
Hardening to any degree between dead soft and full hard is produced by varying the time at the aging temperature. The aging temperature is always the same, 750 F., but is not critical, since it may be varied 100 F. without affecting the resultant hardness. Hardened parts may also be drawn to any lower hardness by heating for a few minutes at between 850 and 1100 F. At the latter temperature, the material will be fully annealed.

To reharden material softened in this manner, it is only necessary to repeat the aging treatment. The elimination of a solution treatment as a prerequisite to aging greatly simplifies the heat treating procedure and accounts for much of the uniformity in physicals.

The deep drawing characteristics and low work hardening rate indicate use for corrugated diaphragms, bourdon tubing, and temperature or pressure responsive bellows. The excellent ductility, both hot and cold, make possible the production of corrosion resistant forgings or upset parts, which may be finish machined and then hardened by heating to 750 F. The field of most varied applications is in the spring industry.

The material is available in all forms in which stainless steel is usually supplied. Cold rolled strip is produced to close thickness tolerances for precision spring applications.

● "Ferrotone" is a simpler chemical blackening finish for ferrous parts, developed by *Turco Products, Inc.*, 6135 S. Central Ave., Los Angeles 1. It uses simple immersion equipment, usually that already available. It operates at a temperature considerably below that for oxide finishing baths. Two oxidizing solutions are not needed. Solely a chemical process, it provides a gleaming black or rich matte finish that is integral with the metal itself. It does not chip, flake or peel under repeated flexing. It will not blister and is not removed by routine cleaning. The process neither increases nor decreases the dimensions of the treated metal.



ACME PHOTO

The righting of the Normandie was a tough assignment, but it proved an opportune school for training hundreds of Navy divers.

Aluminum Alloys furnished by us are also meeting tough assignments daily, such as the punishing service in aircraft, tank and marine engines. At the same time, other much smaller and more delicate parts made from our Alloys are functioning with extreme precision in an equally important, but less spectacular, manner.

In the production of the Alloys to meet these tough assignments, our forces, too, have found a valuable training ground . . . training which will be invaluable to you, in your problems of post-war production.

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Cleveland 5, Ohio

Niagara Falls Smelting & Refining Corp.
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Sonken-Galamba Corporation
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Sandusky, Ohio

The American Metal Company, Limited
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Berg Metals Corporation
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The Cleveland Electro Metals Co.
Cleveland 13, Ohio

Federated Metals Division American Smelting and Refining Company
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111 West Washington Street, Chicago 2, Illinois

Take a Tip from the ANCIENT WARRIOR

He carried only *one* shield. That was his defense against enemy attack. By *placing* it *right*, that one shield was enough. That's the way with your plant equipment. On most jobs you need Stainless Steel only on the exposed surface side.

INGACLAD
STAINLESS-CLAD STEEL

has for 12 years proved its protective efficiency in hundreds of America's finest industrial plants. In addition to stretching your "Stainless Dollars," it offers the additional advantages of easier fabrication and better heat diffusion in kettles and other vessels where heat is applied.

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and many others.

Write for special IngAclad folder and Manual of Fabricating and Welding Procedure.

INGERSOLL STEEL & DISC DIVISION
BORG-WARNER CORPORATION
310 South Michigan Ave., Chicago 4, Illinois
Plants: Chicago, Ill. • New Castle, Ind. • Kalamazoo, Mich.

PRODUCTS OF BORG-WARNER

● A large electronic voltage regulator for supplying constant voltage, a.c. power, to units requiring extremely stable voltage input, is announced by *Harry W. Dietert Co.*, 9330 Roselawn Ave., Detroit 4. It converts the fluctuating voltage from commercial 115 v., 60 cycle, a.c. circuits to a highly stabilized voltage to operate precision photoelectric densitometers, etc. Output power is 160 watts at 110 volts, a.c. Output voltage may be adjusted from 100 to 120 v. The electrical regulation factor is 1000. A frequency change in the input voltage will not vary the output voltage. Stability is attained in 7 min. after starting the unit.

Three-Operation Riveter

Three operations are performed at one stroke of the ram with this electrically-powered T-J "Rivitor," especially adapted to the job of piercing, dimpling and riveting bail ears on pails, using 1¾ lb. tinners' rivets. It is manufactured by *Tomkins-Johnson Co.*, Jackson, Mich.

Rivets are underfed by the machine, as on a standard underfeed "Rivitor." The unpierced pail and ear are placed over the rivet and properly located by gages. When the ram descends, a combination piercing and dimpling die mounted on a spring-actuated pressure pad attached to the ram

forces the work over the rivet, piercing and forming a dimple in the pail and ear.

The dimple is deep enough to prevent the manufactured head of the rivet from projecting inside the pail. At the end of the down stroke, the rivet set (not visible in the photograph because of the pressure pad) forms a slightly rounded head on the rivet.

● An improved line of its series 900 rack-type crossed-axis gear-finishing machines is announced by the *Michigan Tool Co.*, 7171 E. McNichols Rd., Detroit 12. They incorporate two separate hydraulic systems, one for operation of the table and one for the head feed. Improvements in the control system facilitate holding tolerances to even closer limits than previously. Electrical controls have been improved from a safety and durability standpoint.

When it's FIRE EXTINGUISHERS *instead of Flame Throwers*

Strict adherence to specifications for brass and other copper-base alloys produced by Western has enabled manufacturers to meet more successfully the problems of producing war materials. Our years of experience enabled us to meet these important requirements.

When the flames of war have burned out and attention is again turned to peacetime products, Western metals will be available in stamped parts, sheet, strip and long coils. New designs . . . possibly in fire extinguishers, as well as hundreds of other products . . . will require the workability, ageless beauty and long life of copper and related alloys.

The skill and facilities of Western's mills at East Alton, Ill. and New Haven, Conn., are at the disposal of all who work with metals or combine metal parts with non-metallic substances. We'll do our utmost to serve you well . . . now, or in the months to come.

Western BRASS PRODUCTS

Western BRASS MILLS

Division of WESTERN CARTRIDGE COMPANY, *East Alton, Ill.*

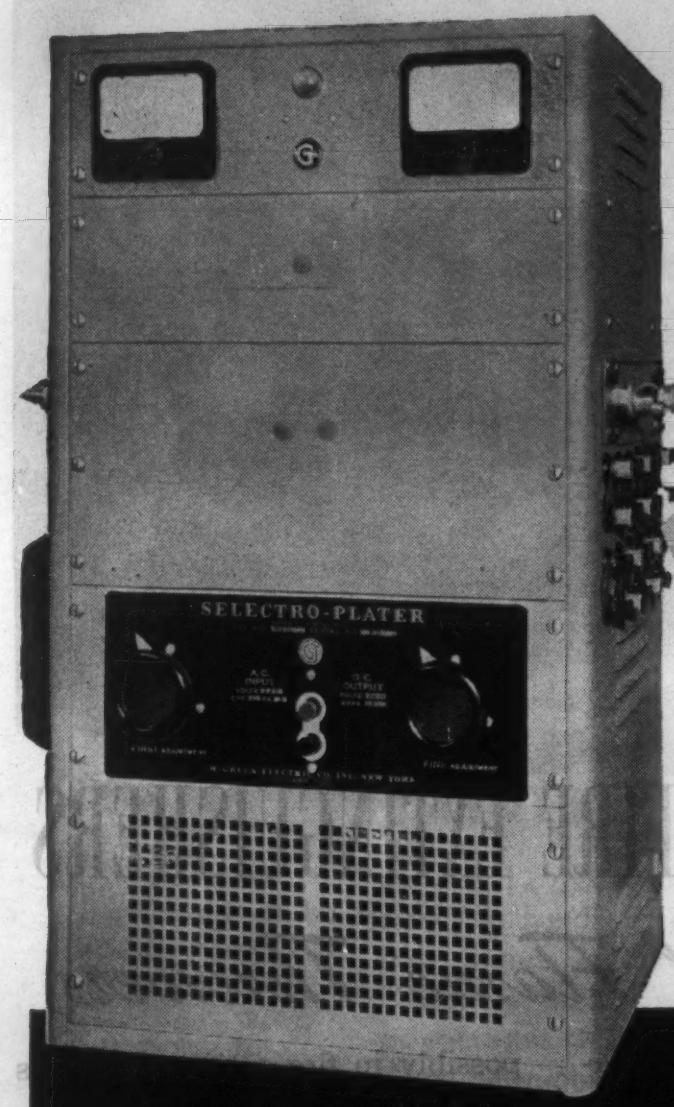
BRASS • BRONZE • PHOSPHOR BRONZE • NICKEL SILVER • COPPER

New in conception and application . . . . . .

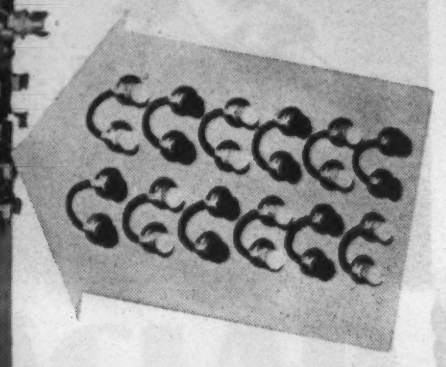
GREEN MULTI-RECTIFIER MR1

. . . providing flexible DC power for laboratory work

New in conception and application, the Green Multi-Rectifier MR1 fulfills a definite need in the laboratory. By providing in one compact unit a flexible DC power supply, the Multi-Rectifier MR1 lifts the restrictions which orthodox rectifiers, generators or batteries impose upon engineers and technicians. By the simple shifting of a few external links a choice of four different voltage ranges is available, with control from zero to maximum on each range.



Unlike present rectifiers, the MR1, designed and developed by Green engineers, incorporates six individual selenium rectifier sections. These may be quickly interconnected by external links to provide four different ranges of DC power:



0-8 volts, max. cap., 100 amps.
0-16 volts, max. cap., 50 amps.
0-24 volts, max. cap., 35 amps.
0-48 volts, max. cap., 18 amps.

On any range, the two panel-mounted voltage control switches offer a range of control in 49 steps from zero to maximum. Maximum current limitations are indicated on each range. For convenience in connecting to loads, output terminals are located on each side of the cabinet. On-Off push buttons control the 3-phase magnetic contactor in the main power supply circuit. Overload warnings are given by supervisory Monitor buzzer and lamp located between the voltmeter and ammeter. The Automatic Watchman furnishes automatic current interruption in case of prolonged overload. Cabinet size: 22" wide x 15" deep x 36¾" high.

For additional information about this new Green development, write for our explanatory brochure, or talk to a Green representative.

W. GREEN ELECTRIC COMPANY, INC.

SELECTRO-PLATERS AND ALL TYPES OF RECTIFIER EQUIPMENT

GREEN EXCHANGE BUILDING 130 CEDAR STREET NEW YORK 6, N.Y.

RECTIFIER G ENGINEERS

Proposed Expansion in Lithium's Use

Recent removal of priority restrictions on lithium opens the way for many new industrial applications of this lightest of all metals, according to Dr. Hans Osborg, vice president, *Lithaloys Corp.*, the country's largest producer of lithium metal and alloys.

"Before the war lithium was used chiefly in metallurgy," Dr. Osborg said. "Its affinity for oxygen and hydrogen, its ability as an alloying constituent, and its value as a scavenger for non-metallic impurities have long been recognized. Wartime research has broadened our knowledge of lithium's possibilities. Production has been increased many times in order to satisfy strategic war requirements. These developments, aided by the removal of priority restrictions, open new post-war horizons for its use."

Lithium and its compounds have various important industrial applications, such as in high conductivity copper castings, tin bronzes, silicon bronzes, aluminum welding, magnesium melting and casting, air conditioning, ceramics, glass-making, and in the heat treating of metals. They also are utilized in the manufacture of low temperature lubricants, air-sea rescue equipment, storage batteries and pharmaceuticals.

Lithium, one-fifth the weight of aluminum, is a silver-white metal that occurs more plentifully in the earth than either lead or tin. The world's richest deposits are in South Dakota and North Carolina, where spodumene is mined.

Lithium is extracted from the ore by chemical processes, and usually obtained as the carbonate from which other lithium salts for industrial use are manufactured. Lithium metal is produced by fused electrolysis, similar to those used in the production of aluminum and magnesium.

● A powerful emulsifying cleaner that is entirely harmless to the worker and the work, called "Swirt," is announced by *Phillips Chemical Co.*, 3405 W. Touhy Ave., Chicago 45. It works on all type of soil: Grease, buffing compounds, cutting and machining coolants and oils and is for ferrous and non-ferrous metals. It is practically odorless and has a high flash point of 155° open cup.

Cutter for Variable Contours

A new application of the Turchan hydraulic follower machine, whereby a lathe can now machine curved surfaces of variable contours, an operation heretofore impossible except by the laborious method of "cut-and-try," has recently been announced by the *Turchan Follower Machine Co.*, 8259 Livernois, Detroit 4.

Using a master pattern or template as a guide, the attachment follows the contour so exactly that a magnesium housing, for instance, is finished to a tolerance of 0.001-in. on both the inside and outside diameters. Making a complete cut every 15 min., the attachment makes it possible to perform in approximately an hour a machining operation which by former hand methods would require several days.

DIE CASTINGS

LARGE OR SMALL

ZINC

ALUMINUM

ALLOYS

WITH COMPLETE TOOL AND FABRICATING FACILITIES

★ ★ ★

Prompt Service Guaranteed

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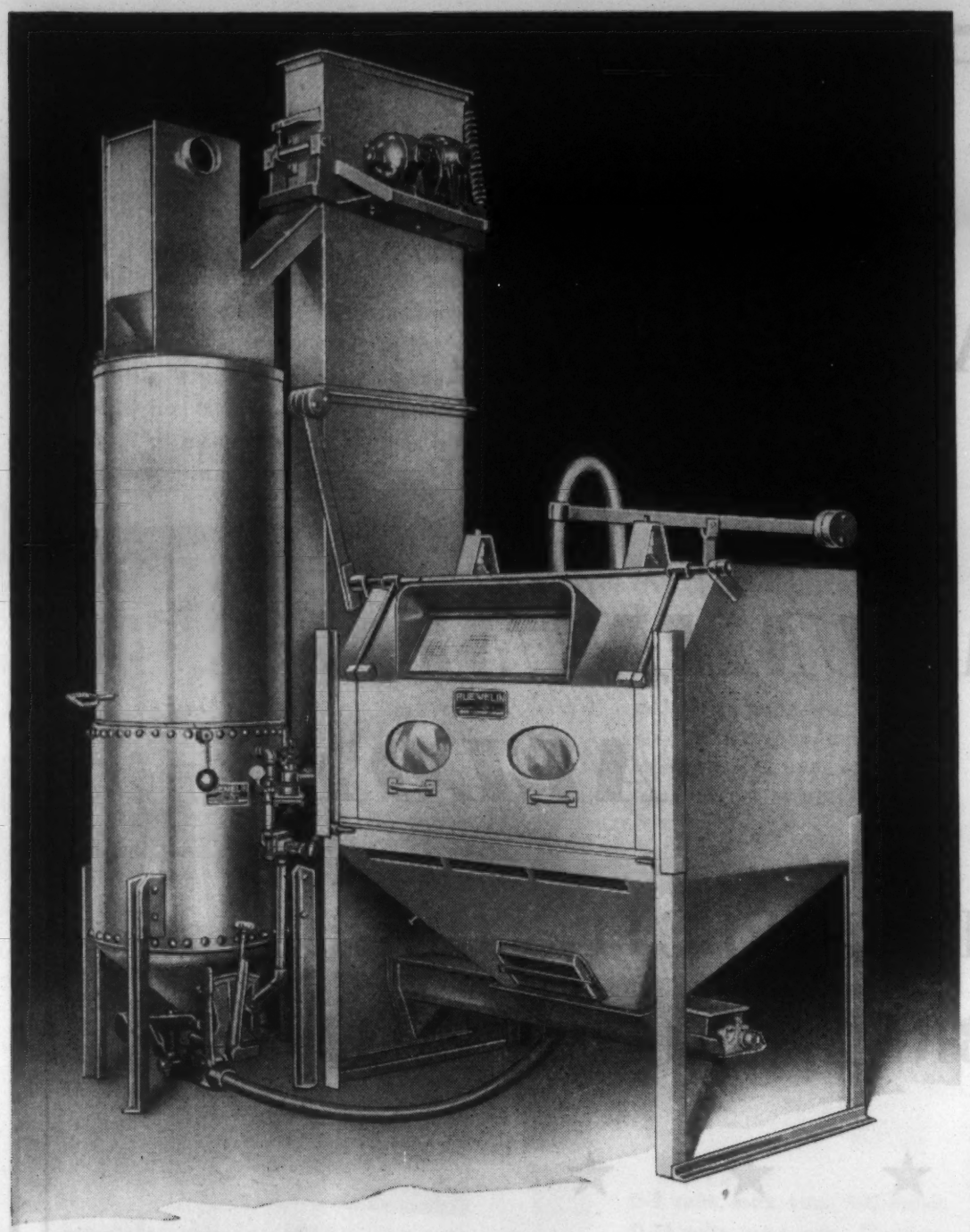


Fast Cleaning
by **DIRECT PRESSURE BLAST!**

Ruemelin Blast Cabinet provides a fast cleaning action by direct pressure blast. Handles a great variety of jobs. Simple to operate. No skilled labor needed. Sanitary. Operator need not wear helmet. Front door loading. Saves footsteps and floor space. Low maintenance cost. No pits or foundation required. Shipped assembled for low installation cost. Handles all classes of abrasives. Over 1,000 in service in foundries, welding shops, steel treating plants, airplane factories, etc.

Write for Bulletin 32-B.

Also manufacturers of Welding Fume Collectors, Abrasive Handling Systems, Cloth Dust Filters, Blast Rooms, and accessories.

RUEMELIN MANUFACTURING COMPANY
3894 NORTH PALMER STREET MILWAUKEE 12, WIS., U. S. A.

RUEMELIN
SAND BLAST EQUIPMENT · TUBULAR DUST FILTERS

A 4397-2/3 A

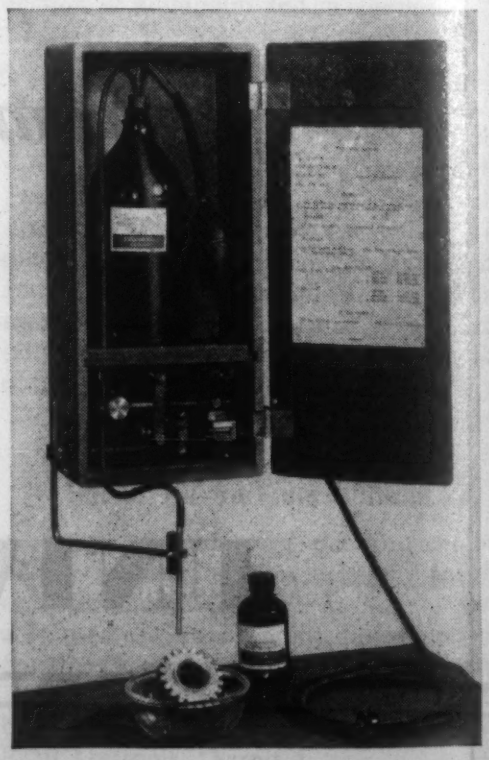
● A new slide rule, featuring the precision of its graduations, is announced by *Charles Bruning Co.*, 102 Reade St., New York. The graduations, being molded in, are an integral part of the rule. Called No. 2401, this 5-in. pocket rule is of high precision and quality. Graduations and numerals of the CI scale are in red. Three screws in the back provide a simple adjustment for tension on the slide. The glass indicator is in a frame of stainless steel. There are nine scales. The beveled edges are in scales of inches and centimeters.

Determinator of Metal Coating Thicknesses

An automatic dropping unit for determining the thickness of cadmium, zinc, copper and tin deposits in the electroplating industry is announced by *Kocour Co.*, 4735 S. Christiana Ave., Chicago 32. It embodies the principles of the Hull & Strausser drop test.

This unit eliminates the necessity of regulating the dropping rate, as it is fixed to deliver 100 drops per min. A counter indicates the number of seconds elapsed. An adjustable arm fastened to the side of the cabinet holds the dropping tip in the desired position.

The solution is fed by a siphon arrangement directly from the standard liter size bottle in the cabinet. Once the set is put into operation, tests may be started and stopped by merely flicking a convenient switch.



A counter is mounted on the panel so that the operator, after preparing and placing a specimen, notes the total at the beginning and again at the end of the test. The difference is the number of seconds required for the solution to penetrate the plate, and the thickness can quickly be determined by referring to the appropriate factor. Convenient factors and charts are supplied with the instrument.

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KOLD-GRIP

GRAIN CEMENT

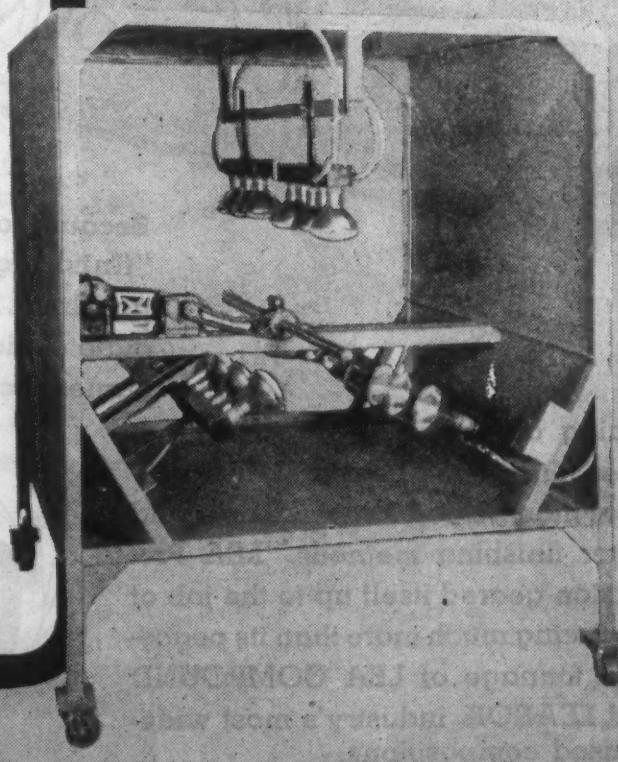
for setting up

POLISHING WHEELS

★ Park Kold-Grip Grain Cement is an ideal binder for setting up any size polishing wheel, for cementing polishing wheel sections together or for recoating abrasive belts and discs. Expertly compounded from a silicate base mixed with organic and inorganic fillers. Available in different grades for various types of polishing operations. Write us today for descriptive literature.

Advantages

1. Clean, odorless and no bacterial attack.
2. No heating required.
3. Economical since cement heads will cut faster and polish more pieces per wheel before reheading is necessary.



Park

PARK CHEMICAL CO.
DETROIT MICHIGAN
8074 MILITARY AVENUE

Park INFRA-RED DRYER

With this portable Infra-Red Dryer, it is now possible to dry polishing wheels in minutes instead of hours after application of "head". This means a definite saving of production time. You can cut down on your wheel inventory by using the same wheels more than once in a single day. Write for specifications and prices.

B-29 . . . KING OF THE SKIES

. . . and little 2-pound bars of LEA COMPOUND play a vital role in the finishing of important parts for this mighty Superfortress at the Bell Aircraft Plant, Marietta, Ga.

Because of its years of experience in "finishing" operations—in burring, polishing, buffing—LEA was the immediate choice of most war-contract companies faced with the necessity of producing articles more precisely finished than ever before. LEA Technical men helped to devise new and better finishing methods. LEA Production geared itself up to the job of producing much more than its peacetime tonnage of LEA COMPOUND and LEAROK, industry's most widely used compositions.

If you are having "finishing" difficulties, why not let us help you?

ARMY E NAVY

THE LEA MANUFACTURING CO.

WATERBURY 86, CONN.

Burring, Buffing and Polishing . . . Manufacturers and Specialists in the Development of Production Methods and Compositions 12-LM-3

Versatile Metal Parts Washer

A three-stage metal washing tank with several new features, designed for use with an emulsifying cleaner or as an alkali washer and comprising a heated solvent tank with two heated water rinse tanks, is presented by *Phillips Mfg. Co.*, 3405 West Touhy Ave., Chicago 45. The heated solvent tank offers a thermostatically controlled range from 135 F. to 250 F., and a drain board which conducts the "drag out" solvent back into its tank.

After immersion in the cleaning agent and draining, the parts are immersed in the first, then the second rinse tanks, emerging, finally, completely oil and dirt free. The water rinse is also heated, with a controlled flow that keeps the temperature at about 180 F., and an ingenious arrangement provides for the removal of most of the dirt and oil in the first rinse so that the final one produces oil-free work.

The solvent tank is heated by strip heaters and the water rinse by immersion heaters. The heated tank's walls are insulated and working parts are easily accessible.

Two safety covers hang at the side of the tank when not in use and protect the operator from contact with the tank itself.

Mobile Rectifier for Magnetic Testing

An unusual d.c. power supply problem, presented by outdoor testing of steel propellor shafts, was solved by a custom-built mobile rectifier unit designed and constructed by the *W. Green Electric Co.*, 130 Cedar St., New York 6, for the Bethlehem Steel Co. It supplies d.c. for a "magnetic particle inspection" process that reveals flaws in the shafts.

The mobile rectifier unit for magnetic testing is a power supply unit that has a continuous capacity of 1500 amp. d.c., with proportionately higher rating for intermittent operation. The output voltage is adjustable in eight steps from one to six volts.

A fan-cooled selenium rectifier assembly is the heart of the unit. Deep "rain-proof" louvres at each end provide for air intake and exhaust.

D.c. output terminals on each side, also the control panel, are in recesses in the cabinet walls. The control panel is equipped with fan starting switch, push buttons for main contactor control, voltage adjustment switch, pilot lamp, visual and audible overload warning signals, voltmeter and ammeter.

Three-phase, 440-v., 25-cycle power supply is brought to the unit through a 25-ft. cable which plugs into a weatherproof receptacle at one end of the cabinet.

Except for the fan, there are no moving parts. If inspection is necessary, the entire top of the cabinet can be removed.

The unit is mounted on heavy-duty, rubber-tired, swivel wheels, and sling holes are provided at the four upper corners to permit crane handling.

by assuring MORE PRESENTEE-ISM

KIRK & BLUM DUST and FUME CONTROL HAS MADE A SUBSTANTIAL CONTRIBUTION TO *Victory*

Workers who breathe clear, clean air, free of harmful dust and fumes, are far less susceptible to common or occupational diseases . . . far less apt to join the ranks of temporary or permanent "absenteeism." These "presentees" are not only more consistently on the job—they do a more consistently better job.

This is *fact*—proved throughout our period of intensified war production just as it had been previously proved in peace time. The evidence speaks for itself, in the hundreds of plants equipped with efficient dust and fume control systems designed and installed by Kirk & Blum "air engineers."

Kirk & Blum systems are backed by 37 years of specialized engineering experience.

Designed to meet individual plant requirements, they guard workers' health . . . increase man-hours and man-efficiency . . . retard deterioration of machinery and other equipment . . . step up production and lower costs.

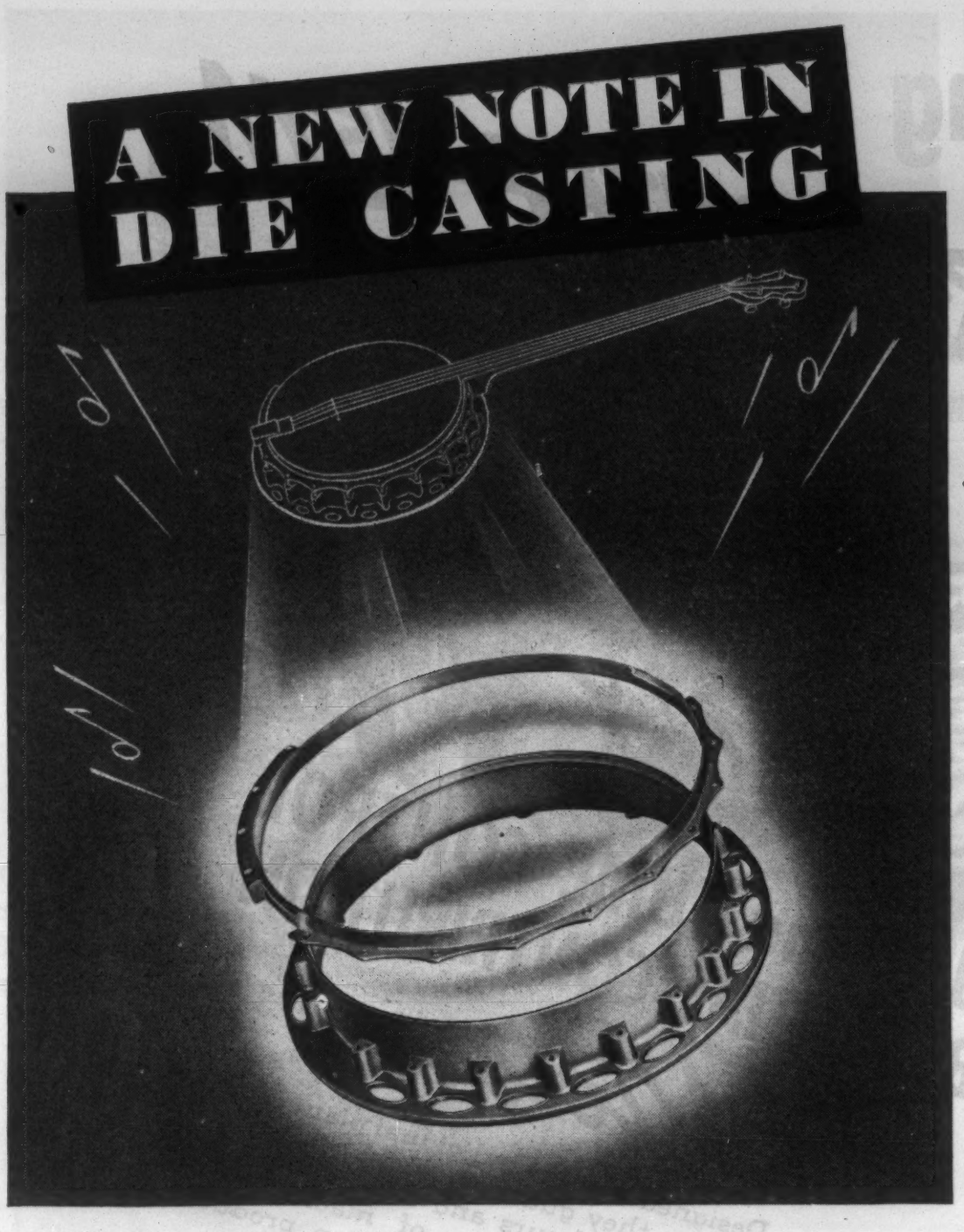
In modernizing present equipment or planning for reconversion, you'll be wise to follow the example of leading industries everywhere—by getting the unbiased counsel of K & B "air engineers" on all problems of dust or fume control.

Send for Booklets

Dust Collecting Systems in Metal Industries
Fan Systems for Various Industries
Blower Systems for Woodworking Plants
Industrial Ovens
Cooling Systems for the Glass Industry
Data on Kirk & Blum Production Facilities

The KIRK & BLUM MANUFACTURING CO.
2852 SPRING GROVE AVE. CINCINNATI 25, OHIO

KIRK AND BLUM



ONE PART REPLACES 70!

The impressive swing to die-casting is not confined to war products. Examples of Advance "engineering to your advantage" include this remarkable banjo One-Piece-Rim-and-Resonator-Flange-Unit in which over 70 different parts are eliminated, and even the 20 brackets for top-tensioning screws are cast integral.

Besides affording sweeping manufacturing economies, this revolutionary unit with its companion Straining Hoop and Arm Rest set new standards for strength and rigidity, give vastly improved resonance and tone, and a tension unaffected by humidity and temperature changes,—a vastly superior instrument!

Product by product, industry by industry, die-casting is replacing costlier, less accurate, less dependable methods of fabrication. Why not consider die-casting in the construction of your post war products? Team up with Advance experience and let our engineers cooperate.

Your inquiry, with sketch or blue print, involves no obligation

ADVANCE PRESSURE CASTINGS, INC.

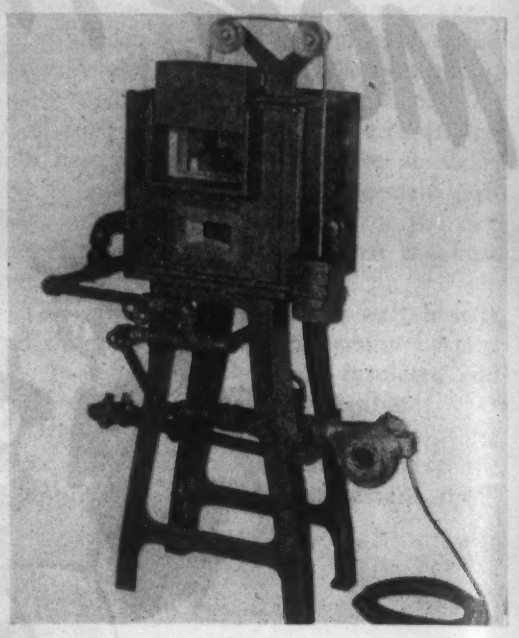
Engineers, Designers and Manufacturers of Die-Castings of "Quality with Economy"

48 North 15th St. Brooklyn 22, N. Y.

Multi-Purpose Tool Room Furnace

A new pedestal type multi-purpose heat-treating furnace is introduced by the *Barkling Fuel Engineering Co.*, 400 N. Paulina St., Chicago 22, which provides three heating areas in one installation.

It has an indirect heating chamber for hardening, annealing, stress relieving and carburizing; with door opening 4½ by 8 in.; a direct heat chamber for heating for tool dressing, forging, bending; with opposed openings in front and back, 2 by 4½ in.; and a tempering surface on the top for tempering tools and dies.

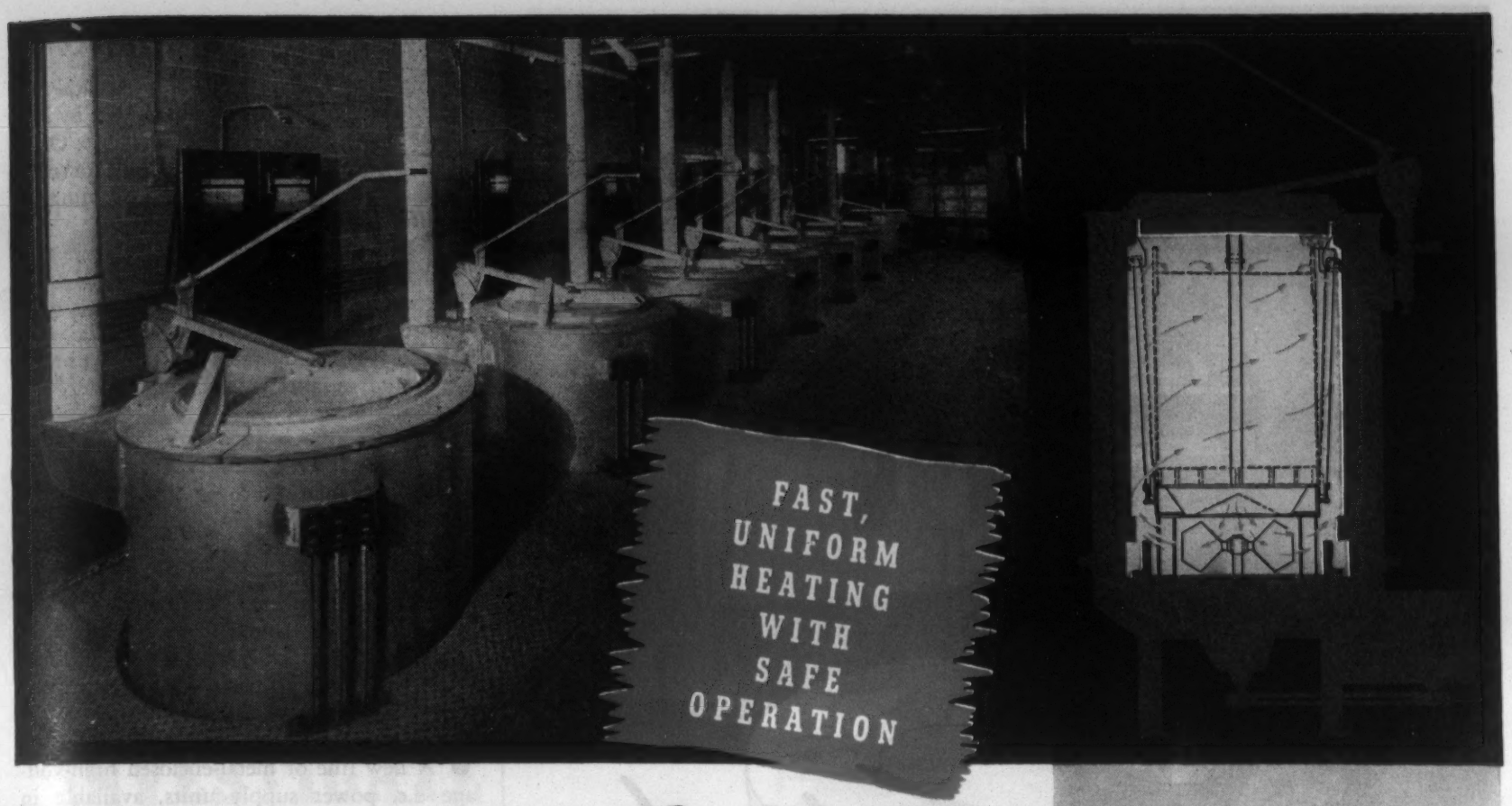


The indirect heating chamber has a "U"-shaped hearth 6 in. between the ribs and 8 in. deep, which can be replaced through the door. The interior is over 410 cu. in. and heats to a temperature of 1500 F. in 10 min., 1900 F. in 29½ min. Temperatures up to 2500 F. are obtained in the direct heat chamber.

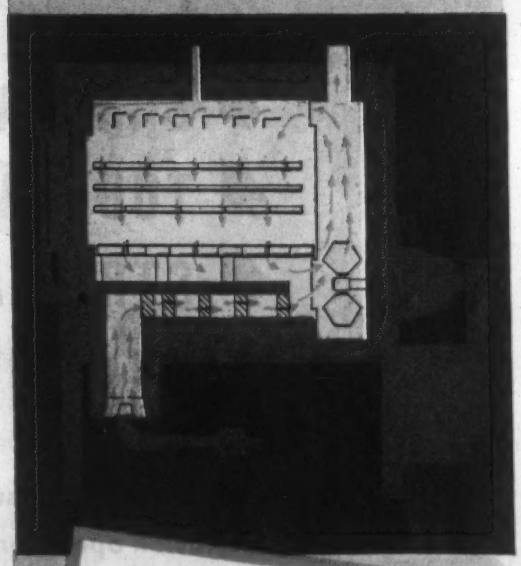
Maintaining of constant heats, without customary fluctuations, is made possible by the air relief valve, operating in conjunction with a specially designed blower that eliminates variations in pressure. The overall dimensions of the furnace are 25 in. wide, 19 in. deep and 53 in. high.

Other features include counterbalanced door, gas-air ration mixing valves, and capped connection for attaching pot-type furnace employing the single blower for both units.

● A non-metallic abrasive facing, used as an industrial cleaning and surfacing medium, called "Downite" is announced by *Downy Products Co.*, 555 Central Ave., Orange, N. J. It is ideal for smoothing, leveling or resurfacing wood, metal and other surface areas, for removing dirt-laden grease or oily metal filings around machinery, for cleaning the hands, etc. Its pliant, long-lasting surface contains myriads of plastic-abrasive microscopic beads suspended by immeasurable tiny cotton cushions. These are attached to a strong cellular woven base fabric which retains the lubricating filament of soap and water. Unlike steel wool, it will not crumble, crack, shred or disintegrate.



Cross sections shown above (Pit Type) and below (Oven Type) incorporate arrows to indicate the thorough circulation of hot gases within the furnace.



SURFACE COMBUSTION *Standard Rated* CONVECTION FURNACES

● Convection heating has become the most successful method of heating large masses of small parts quickly and uniformly. Furnaces to utilize this principle to the fullest extent must be equipped with a recirculating fan of large capacity and gas burner equipment for instantaneous operation. This, of necessity, involves additional operations to start and stop the equipment. The fan, the burners and the pilot must each be started in the proper sequence.

Surface Combustion Standard Rated Convection Furnaces are designed so that they can be easily equipped with Safeguard Control Units. These units are Factory Mutual Approved and automatically control the sequences of starting and the proper operation of the furnace. The operator need push only the start and stop buttons.

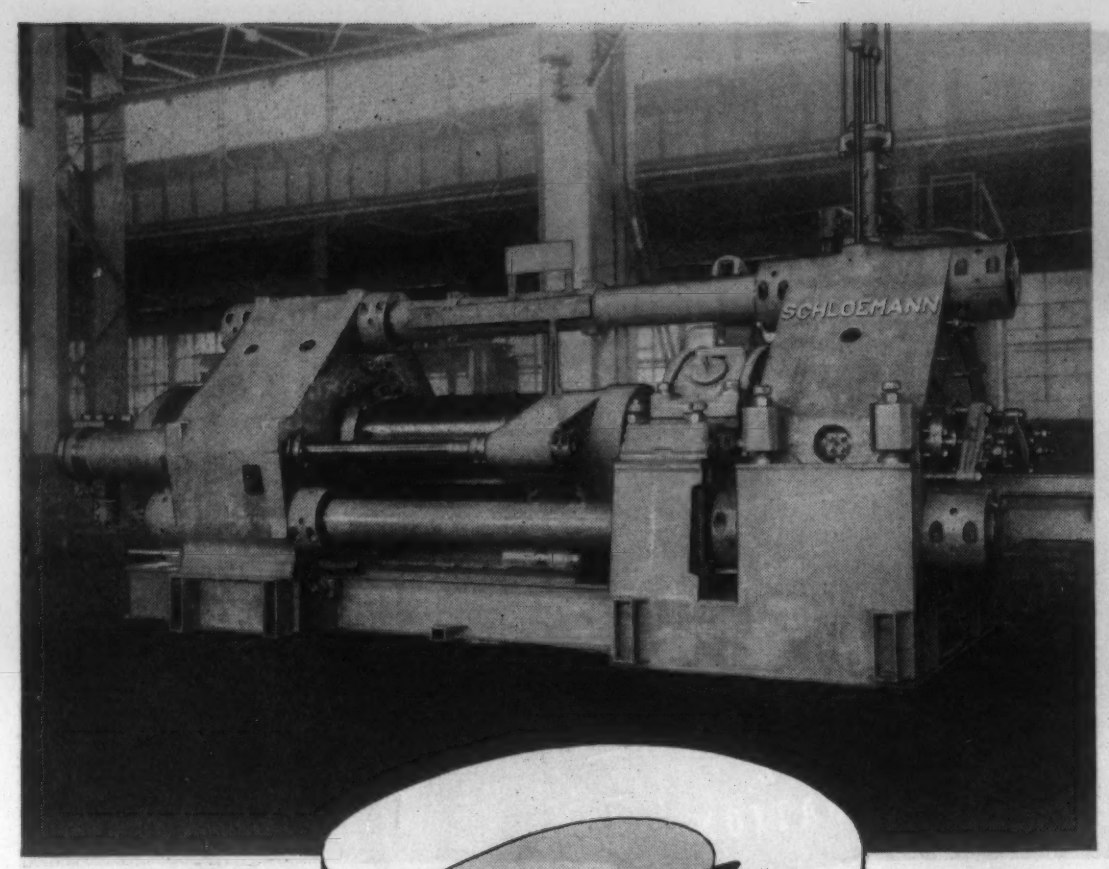
Standard Safeguard Control Units can be supplied with the furnace as accessory equipment and can be applied to the furnace at any time. Eliminate the human element, use the furnace that can be automatically safeguarded.

For complete data request Bulletin CG-43 "DESIGN FEATURES OF SURFACE COMBUSTION STANDARD RATED CONVECTION FURNACES"

The Heat Treater's Helping Hand **'Surface'**

SURFACE COMBUSTION • TOLEDO 1, OHIO

Standard and Special Industrial Furnace Equipment For:
Forging, Normalizing, Annealing, Hardening, Drawing, Carburizing, Nitriding and Heating. Special Atmosphere Generators. Write for Bulletins.



Do You Extrude..

- BARS AND RODS
- TUBULAR PRODUCTS
- STRIP AND WIRE ROD
- ANY KIND OF SECTIONS

SCHLOEMANN presses assure the greatest possible efficiency in extrusion operations—an assurance based on:

✓ High quality of products extruded
✓ Dependability of performance
✓ Ease of operation
✓ Low cost of operation and maintenance
✓ Great range of sizes obtainable from one installation

Benefit by these advantages. Permit the experience and skill of Schloemann engineers to increase your production.

SCHLOEMANN
ENGINEERING CORPORATION

1104 Empire Building . . . . . Pittsburgh 22, Pa.

HYDRAULIC PRESSES • ROLLING MILL MACHINERY

Heavy Duty Milling Machine

The new Defiance No. 540 vertical hydraulic feed machine, manufactured by *Defiance Machine Works, Inc.,* Defiance, Ohio, is designed for heavy duty single or multiple spindle drilling, boring, reaming or milling operations.

The column is a heavy-type cored casting with long ways, which carry the head slide. The ways are oiled by a Bijur oiling system. The column supports the hydraulic feed cylinder, which operates the head; also encloses the weights that counter balance the head and slide.

The machine is provided with an automatic cycle of rapid approach, feed (adjustable), rapid return to stop. The cycle can be arranged with a dwell at the end of feed if so desired. The head is driven through a multiple "V" belt and provided with one pair of pick off change gears to give a speed of from 200 to 500 r.p.m. as selected, at the power take off. The main drive bracket and head are automatically lubricated.

● A new line of metal-enclosed high-voltage d.c. power supply units, available in ratings up to 50,000 volts d.c. is announced by *General Electric Co.,* Schenectady. They are applicable to induction heating and other industrial and electronic applications. Each unit consists of a full-wave kenotron rectifier, a filter to limit voltage ripple to 1% or less and a complete control equipment. The d.c. output voltage can be controlled from zero to maximum by a motor-operated, dry-type, variable autotransformer. Among the safety features is an automatic solenoid-operated discharge switch.

Shortstub Electrode Holder

A new electrode holder, designed to allow unobstructed visibility while welding and maximum accessibility even for deep pocket work, fast loading and reloading, plus the feature of more completely using up the electrode, has just been announced by *National Cylinder Gas Co.,* 205 W. Wacker Drive, Chicago 6.

One of the big wartime wastes has been the too-long stub end that was regularly pulled out of the electrode holder before it was consumed in the weld area and thrown into scrap, perhaps while there was 2 to 4 in. of usable rod left, because of the improper design of the tool used to hold them. Dollar losses in electrodes have averaged 7%, with particularly heavy losses in the more costly metals.

The *Hollup Corp.,* Chicago, division of *National Cylinder Gas Co.,* solved this problem through its new "Shortstub" electrode holder, designed and available to increase the usable portion of the electrode to the uncoated end of the rod. With it only ½ in. is needed for a tight, efficient current contact in the holder jaw. An extension of the holder itself allows the now usable stub end of the rod to be projected into the proper position for welding.

The new holder, completely insulated, loads and unloads in a second; and because of its perfect balance and light weight, minimizes operator fatigue with practically complete use of valuable electrode metal.

WORRIED ABOUT CORROSION ON THOSE ZINC PLATED PARTS?

INVESTIGATE ANOZINC*

Simple anodic treatment gives zinc surfaces greater protection against corrosion and outdoor exposure.

If your zinc plated parts need extra armor against rust, provide it economically with ANOZINC — the bath that steps up service life of zinc plating — makes it more resistant to corrosion and handling. For example — Parts finished in the Anozinc solution have stood up under the Army-Navy salt spray test AN-QQ-S-91 for over 200 hours.

Here are the highlights of what the ANOZINC bath offers:

AN INEXPENSIVE METHOD of producing by anodic treatment a durable finish on zinc plate. The moderate-priced salts, short operating cycle and standard drying procedures combine to keep the cost low.

SIMPLE EQUIPMENT. Your ordinary plating facilities in most cases can be readily converted to use this bath. ANOZINC salts are convenient to handle, ship and store.

EASILY CONTROLLED SOLUTION. It's readily maintained and doesn't require frequent additions. The bath, operating at room temperature, needs no heating or refrigeration . . . produces a temperature-stable surface which is an excellent base for baking or air-drying paints and lacquers.

TWO ATTRACTIVE FINISHES can be obtained — a deep, semi-lustrous black, and a brassy, slightly iridescent yellow — a different bath being used for each finish. Slight variations are also possible within the two color ranges.

FURTHER INFORMATION will be sent promptly — write to the nearest office below. Mention the kind, quantity and size of parts to be treated. Your inquiry will receive immediate attention.

OTHER U. C. PRODUCTS AND PROCESSES TO SERVE YOU

CHROMIUM PLATING for wear-resisting, oil-retaining and other types of finishes.

☆**UNICHROME ALKALINE COPPER** for smooth, lustrous copper plating in a non-cyanide bath.

☆**UNICHROME STRIP** for speedy removal of copper, chromium, zinc, etc., from steel and cast iron without etching the base.

☆**UNICHROME RACK COATINGS** specially formulated to stand up under the most severe operating cycles.

☆**UNICHROME STOP-OFF LACQUERS AND COMPOUNDS** specially formulated to meet specific plating problems.

☆**UNICHROME CLEAR LACQUERS** specially formulated to meet specific finishing requirements.

☆**UCILON** — a corrosion-resistant coating for protecting surfaces against acids, alkalies, water, gasoline and various corrosive chemicals.

☆Reg. U. S. Pat. Off.

UNITED CHROMIUM INCORPORATED

51 East 42nd St., New York 17, N. Y.
Waterbury 90, Conn.
Detroit 7, Mich.

Amersil*

(TRADE NAME REGISTERED)

ASSURES FINISHED PRODUCT PURITY

Because Amersil* (fused silica) is 99.8% pure silicon dioxide, it cannot contaminate acids or other chemicals handled in piping, cooling sections, absorbers, etc., made of it and absolute purity of the finished product is assured.

Amersil* is unaffected by any of the mineral acids—except hydroflouric (at all temperatures), and phosphoric above 270°F.—or by the halogens, with the exception of flourine. It withstands, permanently, temperatures up to 2100° F., with peaks up to 2700°F. permissible for short periods. Amersil's ability to withstand sudden and extreme thermal shocks without noticeable expansion or contraction is another of its many valuable characteristics.

For purer finished products, use Amersil* apparatus.

A new Amersil* Catalog is on the press. Write today—on your business letterhead, please—and reserve a copy.

*The registered trade name of the only American manufacturer of a complete line of fused silica products.

AMERSIL COMPANY Inc.

A subsidiary of Nichols Engineering & Research Corp.

60 WALL TOWER NEW YORK 5, N. Y.

HARDNESS TESTING

of PLATED SURFACES,

SINGLE GRAINS IN ALLOYS,

NITRIDED AND CYANIDED LAYERS,

and PIECES TOO SMALL FOR OTHER TESTERS!

The Eberbach Micro Hardness Tester accurately measures hardness of micro constituents of metallic alloys. With this modern laboratory tool you can check hardness specifications quickly, easily, and directly.

The tester includes an indenter unit designed to mount on any metallurgical type microscope. A diamond indenter permits measurement directly in fundamental units, instantly convertible to other systems.

Write for full details

Eberbach & Son Company

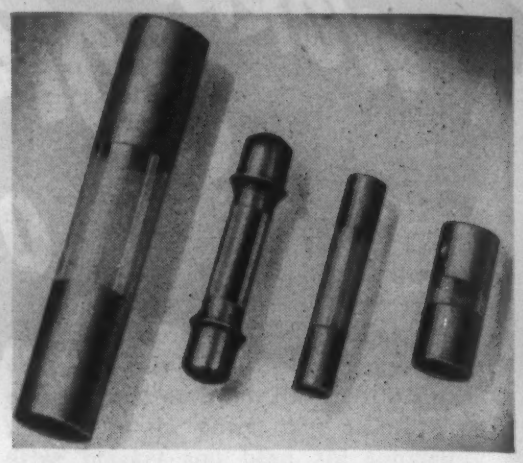
ANN ARBOR, MICH.

LABORATORY APPARATUS & SUPPLIES

ESTABLISHED 1843

Metal Plating on Glass and Ceramics

The unusual adhesion obtained by Electro Plastic Processes in plating on plastic materials has been further adapted for application to glass and ceramics. Laboratory and field tests indicate greatly improved hermetic sealing. Tests on Pyrex glass have been conducted by heating the solder



sealed piece to 350 F. and immersing it immediately into dry ice, indicating the adaptability of the new process for all temperature ranges.

Adhesion obtained is much better than that of other commonly used methods. Any normal soldering method is satisfactory—hot iron, oven soldering or electronic, and no special solders are required.

The process is adaptable to the hermetic sealing of such electrical components as resistors, condensers, small relays, transformers, instruments, etc. Either glass or ceramic cases can be plated with a metallic band for soldering to metallic end caps or insulators plated for solder sealing to metallic containers.

Details may be had by addressing *Electro Plastic Processes,* 2035 W. Charleston St., Chicago 47.

● A new assembly of wide field magnifiers with built-in illuminating units, operated by battery and electric control, containing 7-power, 20-power and 40-power magnifiers, is announced by *R. P. Cargille,* 118 Liberty St., New York 6. They are useful for inspecting plating for pitting, pinholes, texture; for inspecting metal for incipient cracks; for inspecting welds for cracks; for detecting incipient corrosion, etc.

Machine to Remove Broken Tools

A metal disintegrator to remove broken tools embedded in dies and work pieces is announced by *Drafto Corp.,* Cochranton, Pa. It will extract broken taps, drills and studs from various metal dies and work pieces.

It is in a compact, portable, self-contained unit, operating on any 110-v.-60 cycle power source. Any metal can be disintegrated by a vibrating arc centering directly over the embedded material.

A special coolant assists disintegration, helps cool electrodes, and prevents heat distortion. There can be no damage to delicate contours of dies or work pieces. The average shop man can operate it efficiently.

THE NEW

BALDWIN PRODUCTS

BOOK IS READY FOR YOU

There is hardly an industrial field that does not use one or more of the many products listed and pictured on the pages of this new Baldwin bulletin. Between its covers you may find ways that Baldwin can help you with your immediate production problems or with your post-war plans.

A handy index of all the major products of The Baldwin Group, arranged in accordance with their applications in particular industries, will enable you to see at a glance where Baldwin can be of service. A request for Bulletin 211, on your regular letterhead, will bring this book to your desk without obligation on your part.

The Baldwin Locomotive Works, Philadelphia, Pa., U. S. A. Offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Detroit, Houston.

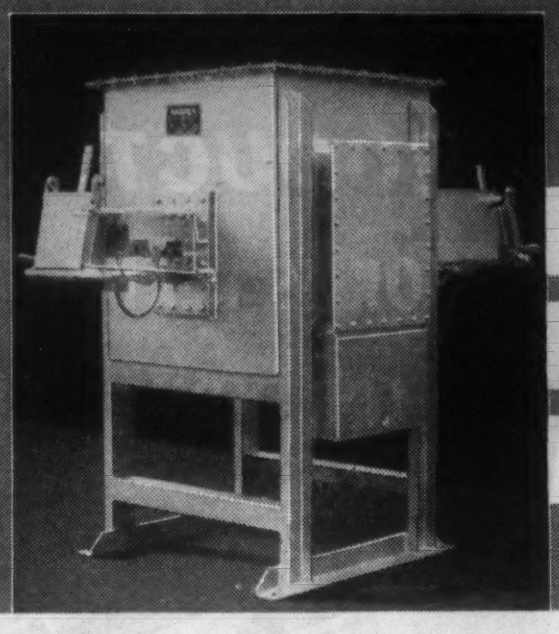
BLW THE BALDWIN GROUP

BALDWIN

The Baldwin Locomotive Works, Philadelphia, Pennsylvania: Locomotive & Ordnance Division; Baldwin Southwark Division; Cramp Brass and Iron Foundries Division; Standard Steel Works Division; The Whitcomb Locomotive Co.; The Pelton Water Wheel Co.; The Midvale Co.

Harper

HIGH TEMPERATURE



Electric Furnaces for

SINTERING POWDERED METALS

Temperatures up to 2750°F. Gastight construction for atmosphere control. Photograph shows entrance, high temperature and water cooled chambers with flame seal at entrance and exit for continuous operation. Various sizes for research and mass production. Used by America's foremost concerns. Write for engineering data.

HARPER ELECTRIC FURNACE CORP.

1461 Buffalo Ave., Niagara Falls, N. Y. Incorporated 1924

IF THERE IS A FLAW "FLASH-O-LENS" WILL FIND IT!

The new FLASH-O-LENS offers foundry-men, machinists, and many others engaged in producing metal parts for war contracts an efficient, economical means of examining the most minute defects during routine inspections.

FLASH-O-LENS consists of a portable 40x microscope combined with a perfect source of illumination in one convenient, compact unit . . . They are available in several models—powered by either standard flash light dry cells or by current from any AC or DC outlet—and with a selection of various combinations of lenses, all interchangeable in the one lens housing.

Send today for illustrated catalog describing the new FLASH-O-LENS

E. W. PIKE & COMPANY

PIKE

Manufacturers ELIZABETH, N. J.

Plastics for Temperature Variations

A new phenolic molding compound specially formulated for use where temperature variations occur frequently, as in automotive ignition parts—distributors, rotors, coil tops, etc.—has just been announced by *Durez Plastics & Chemicals, Inc.*, Walck Road, North Tonawanda, N. Y.

This material, designated as "Durez 12708 Natural," is a mineral-filled phenolic which is said to have a very low mold-shrinkage factor, thereby making it particularly adaptable for use in parts that require metal inserts.

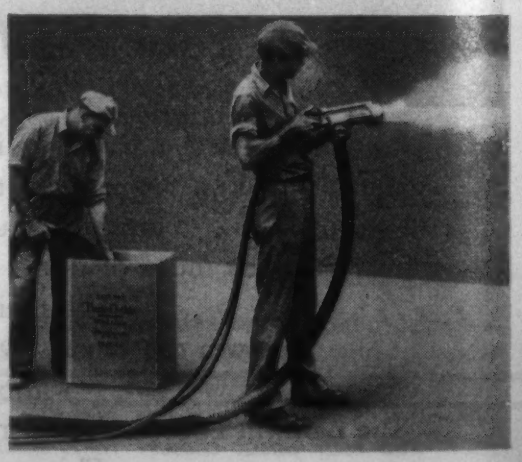
This low shrinkage is claimed to reduce stress around the inserts, and renders the finished part less susceptible to cracking. This new molding material may be easily preformed.

Among the physicals are: specific gravity, 1.84; mold shrinkage, inches per inch, 0.003; water absorption 0.04%; dielectric strength, volts per mil at room temperature, 450; dielectric fatigue, volts per mil (step by step method) 350; power factor at room temperature, 0.05; dielectric constant at room temperature (60 cycles) 5.

● A high heat resisting paint, which the sponsors call "sensational," is announced by *Quigley Co., Inc.*, 527 Fifth Ave., New York 17. Called "Triple-A," it will adhere on light steel under rapid heating and cooling up to 1400 F.; on alloy steel, brick, etc., it will stand 2500 F. or over. It is non-inflammable, non-irritating and does not give off fumes or odors at any time. It is designed to give both maximum protection and decoration.

Gun for Open-Hearth Walls

A new gun for speeding up the sealing and insulating of open hearth walls and bulkheads is announced by *Illinois Clay Products Co.*, 608 S. Dearborn St., Chicago 5. The gun siphons dry "Therm-O-Flake" insulation direct from the shipping carton,



mixes with water and sprays to the refractory wall in one operation. It eliminates pre-mixing and application is six to eight times faster than by manual methods.

The gun operates on standard air and water pressures, and weighs 4 lb. Units are shipped complete with 15 ft. sections of air, water and vacuum hose and all necessary valves and fittings.

Performance Proven Graphitic Steels—

USED TO LICK TOUGH JOBS

75 M M High Explosive Shell nosing die made of Graph-Tung Steel produced 350,000 shells. Dies made of competing steel produced only 5,000.

Used for cold nosing dies, gauges, lathe centers, knives to cut synthetic rubber and many other difficult applications, Graphitic Steels have consistently provided longer tool and die life.

Graphitic Steels are able to lick tough jobs because they possess stubborn resistance to wear - - excellent response to heat treatment - - have less tendency to scuff and score and are easily machined.

Secure improved tool and die life by using one of the five Timken Graphitic Steels - - Graph-Mo, Graph-Tung, Graph-Sil, Graph-Al or Graph-M.N.S. Each has been designed for specific applications. If you wish, a member of our technical organization will be glad to recommend the proper steel for your job. Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

Knives for hard-to-cut paper and synthetic rubber gave improved service and were fabricated faster when produced from free machining Graph-Mo Steel.

Lathe centers made of Graph-Tung Steel provided three times the life of competing steel.

Remarkable freedom from growth and good wear resistance of Graph-Mo Steel make it ideal material for gauges.

TIMKEN
TRADE MARK REG. U. S. PAT. OFF.
GRAPHITIC STEELS

C-F POSITIONERS

In Any Welding Operation It's "Position" That Counts

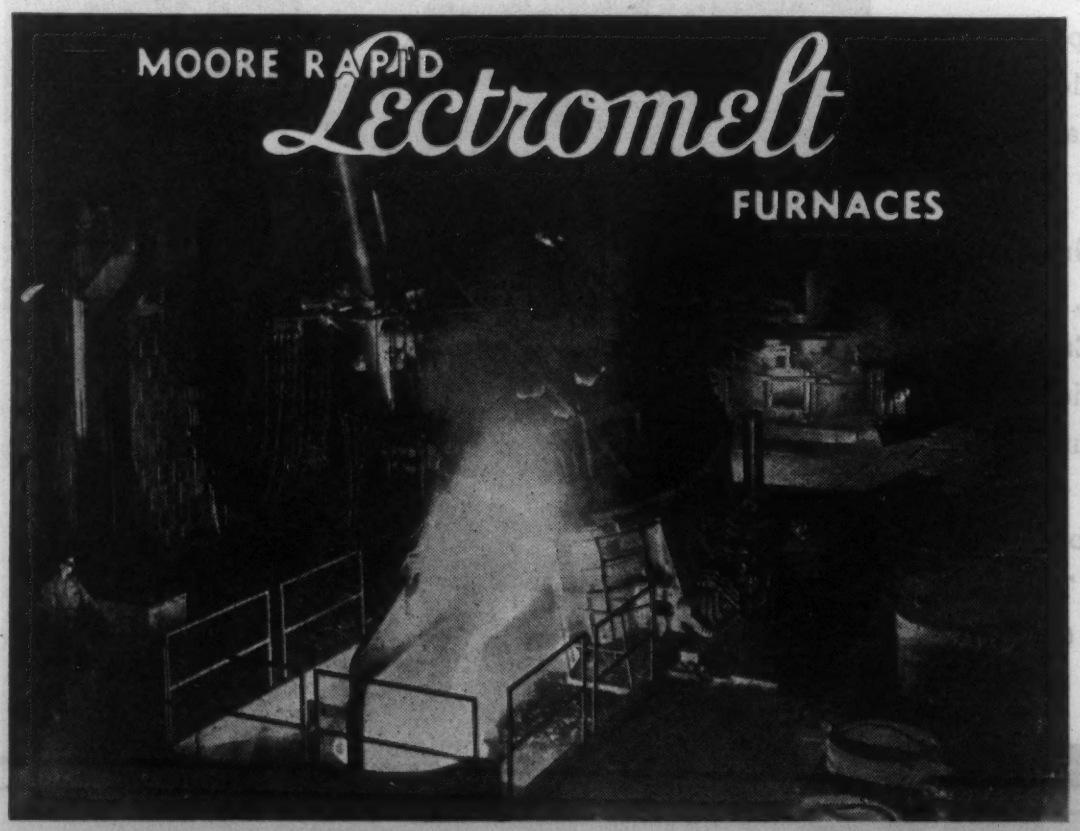
Production welding usually means working on top, bottom and on all sides of the weldment. It means a "quick change" of position should be possible for greater time saving, more efficiency, lower costs and greater safety to men and materials. With C-F positioners a welder can quickly position even the most cumbersome weldments at the press of a button, without crane help or handling crews. With just one set-up of the weldment, he can position it easily, speedily and safely, all alone. He can rotate it a full 360° at variable speeds from 0 R.P.M. up, tilt it to 135° beyond horizontal, and can weld, downhand, all sides surfaces and angles in the one set-up with larger rods and fewer passes. All C-F positioners, both stationary and portable, are pedestal mounted to give maximum floor and working clearance and all are adjustable for height.

Write for Bulletin WP-22

CULLEN-FRIESTEDT CO.

1314 S. KILBOURN AVE. CHICAGO 23, ILL.

MOORE RAPID *Lectromelt* FURNACES



Illustrated is a 20-ton capacity "NT" top charge Lectromelt furnace, in daily use in a West Coast Foundry. Lectromelt top charge furnaces are available from 100 tons down to 250 pounds capacity.

PITTSBURGH LECTROMELT FURNACE CORPORATION

PITTSBURGH, PENNSYLVANIA

Meetings and Expositions

NATIONAL AVIATION TRADES ASSOCIATION, annual meeting. St. Louis, Mo. December 6-8, 1944.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS, annual meeting. New York, N. Y. December 11-13, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, annual meeting. Detroit, Mich. January 8-12, 1945.

GREAT LAKES POWER CLUB AND CHICAGO LIGHTING INSTITUTE, conference on dielectric and induction heating. Chicago, Ill. January 16-18, 1945.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting. New York, N. Y. January 17-19, 1945.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS, annual meeting. Boston, Mass. January 22-24, 1945.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, national technical meeting. New York, N. Y. January 22-26, 1945.

INSTITUTE OF THE AERONAUTICAL SCIENCES, annual meeting. New York, N. Y. January 30-31, February 1, 1945.

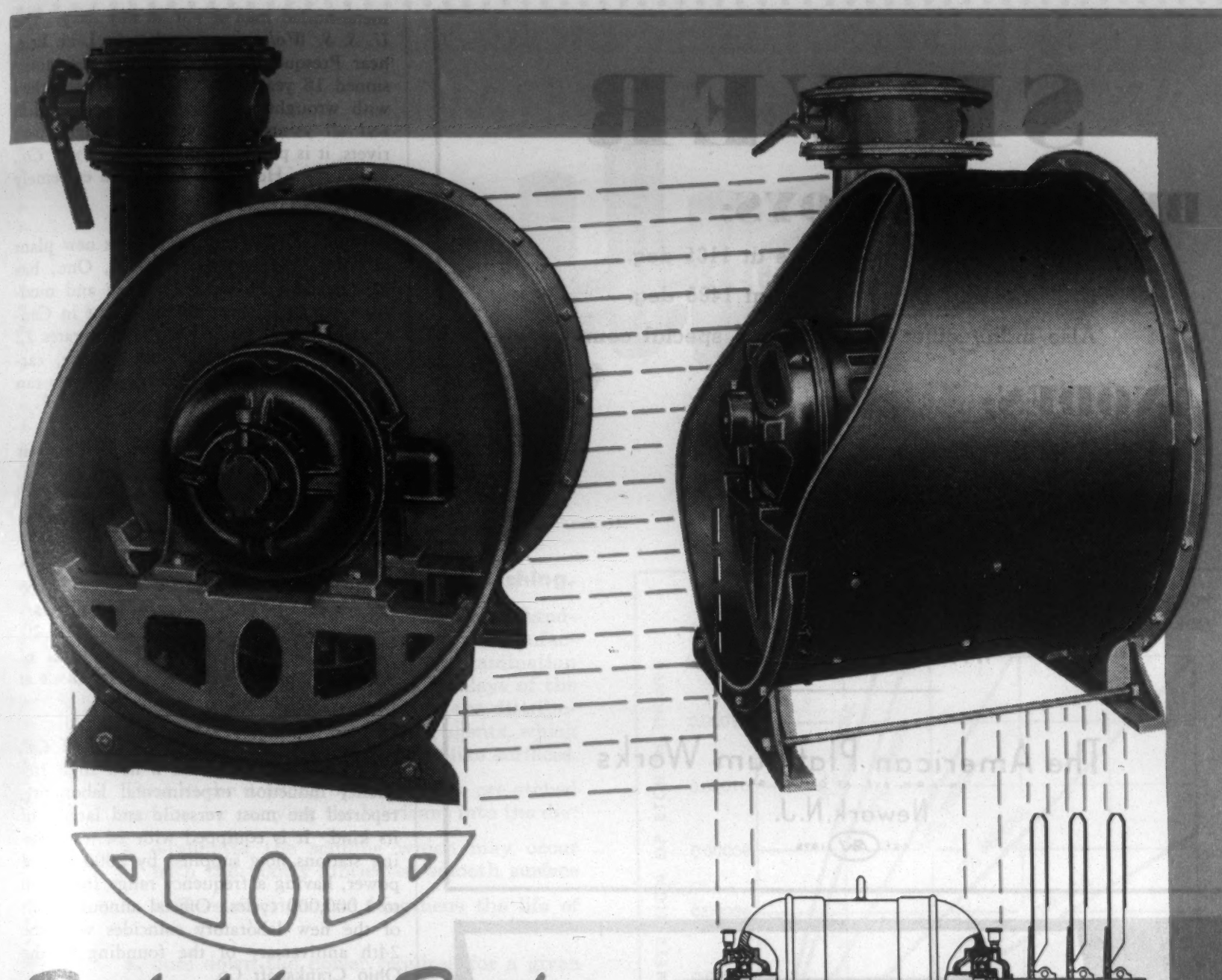
Plants and Slants

A logical approach towards getting returned servicemen happily back into their plant civilian jobs has been taken by *Borg-Warner Corp.*, Chicago. Directors of personnel in more than 20 Borg-Warner plants met with patients at Percy Jones Readjustment Center, Gull Lake, Mich. to learn from the "vets" exactly what they wish for at work, play and in their homes of the future. Personnel directors have concluded that it is they—not the veterans—who are the so-called problem child of post-war employment.

The traveling salesmen of *Westinghouse* are back on the road again—now with loose-leaf binders listing materials declared "surplus" because of changes or curtailment of war contracts. They are calling on other manufacturers and jobbers throughout the country. One purpose is to clear factory floors and warehouses of materials no longer needed and help pave the way for conversion to peace.

"Trim your fingernails" is the rather uninspiring but necessary slogan at a *Western Cartridge Co.* plant where detonators for shells, bombs and other explosive projectiles are handled. The detonator is a tiny metal "cup," about ¼ in. diam., containing sensitive materials which explode the projectile when the fuze collapses on impact. A portion in the center is exposed and protected only by a thin, flexible tin foil 0.003 in. thick. A pointed fingernail would set it off. Fingernail styles for Miss Western Cartridge are therefore rounded. After all, life is more precious than pointed nails.

A most quietly observed anniversary is the centennial of the building of the first

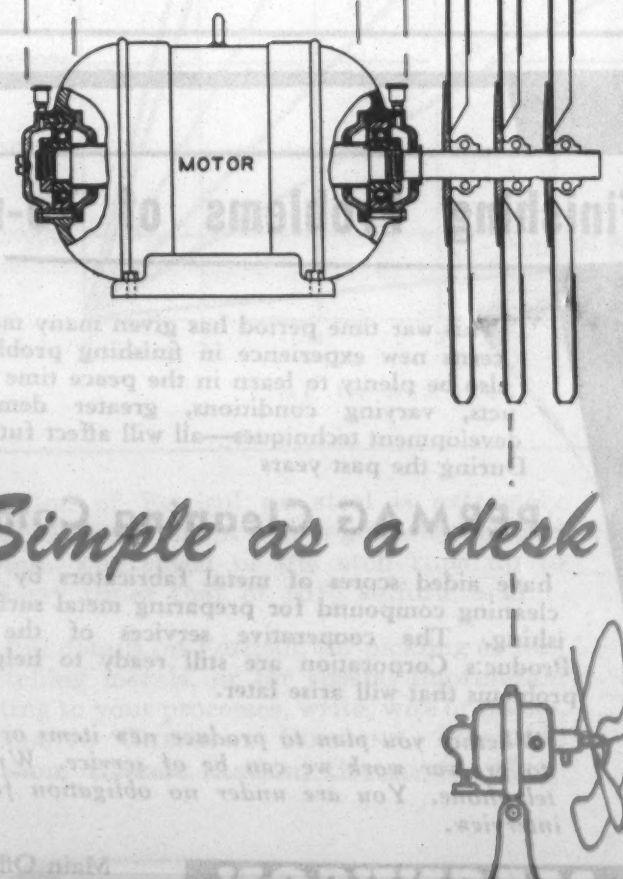


Built like a Bridge

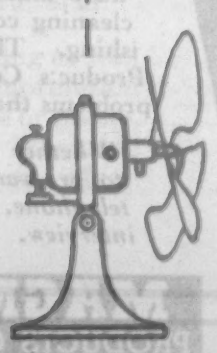
The Spencer Turbo-Compressor consists of a few light weight impellers individually balanced and mounted on an oversized motor shaft rotating at low peripheral speeds, with wide clearances all around.

The one-piece casing is made of copper bearing steel, rolled and welded. End heads are made of special ribbed sections and spun rings. The motor is supported by a cast bridge-work that evenly distributes the weight.

The Spencer Turbo can be mounted anywhere without special foundations on the floor—or on the side or top of a furnace, with the discharge in any one of four positions.



Simple as a desk fan



THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

257-F

TURBO-COMPRESSORS

SILVER

BRAZING ALLOYS:

"Readyflow"—56% Silver—works at 1165 deg.

B 201 —20% Silver—works at 1485 deg.

Also many other standard and special compositions.

ANODES:

Of all desired dimensions.

FLUXES:

For use with Silver Brazing Alloys.

Write for booklet "MA"

The American Platinum Works

N. J. R. R. AVE. AT OLIVER ST.

Newark, N.J.

EST. 1878

Finishing Problems of To-morrow

This war time period has given many metal working concerns new experience in finishing problems. There will also be plenty to learn in the peace time era. New products, varying conditions, greater demands, different development techniques—all will affect future production. During the past years

PERMAG Cleaning Compounds

have aided scores of metal fabricators by furnishing a cleaning compound for preparing metal surfaces for finishing. The cooperative services of the Magnuson Products Corporation are still ready to help solve the problems that will arise later.

Whether you plan to produce new items or revert to pre-war work we can be of service. Write or telephone. You are under no obligation for an interview.

MAGNUSON PRODUCTS CORPORATION

Main Office
50 Court Street
Brooklyn 2, N. Y.
Nationally Represented

Canadian Offices: Montreal - Toronto. Canadian PERMAG Products Ltd.

PERMAG CLEANING COMPOUNDS

More than 340 Cleaning Compounds are now made under the PERMAG trade name to meet the growing demands of industry.

metal-hulled man-of-war in any navy. The *U. S. S. Wolverine* now lies in Lake Erie, near Presque Isle, having been decommissioned 18 years ago. Her hull is sheathed with wrought iron plates, 5/16 in. thick, and all joints riveted with wrought iron rivets, it is pointed out by *A. M. Byers Co.*, Pittsburgh. Her history has been extremely interesting.

Colonial Tool Co., Ltd., in its new plant at 1691 Walker Rd., Windsor, Ont., has in operation the most complete and modern commercial heat-treating plant in Canada. Producing cutting tools, it operates 22 furnaces and baths for heat-treating, carburizing and cyaniding. Some furnaces can handle work up to 7 ft. long.

All but 11 of the nearly 12,000 war work employees at Chicago plants of *Pullman-Standard Car Mfg. Co.* have signed voluntary pledges to stay on the job on V-E Day.

Production of torpedoes for the Navy by the *Amertop Corp.*, St. Louis, subsidiary of *American Can Co.*, will cease April 30, 1945. The reason is the development of improved types of torpedoes, to be made at Navy-owned plants.

The *Tocco Div., Ohio Crankshaft Co.*, Cleveland, has completed a new high frequency induction experimental laboratory, reported the most versatile and largest of its kind. It is equipped with 24 test heating stations now supplied by 2000 kw. of power, having a frequency range from 960 to 1,000,000 cycles. Official announcement of the new laboratory coincides with the 24th anniversary of the founding of the Ohio Crankshaft Co.

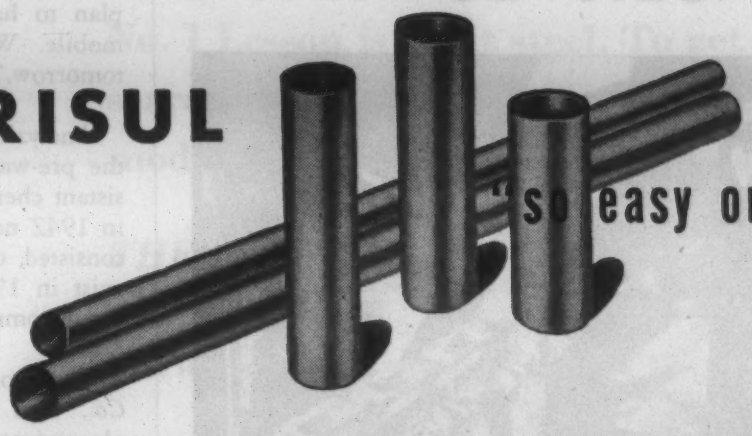
The new Whitemarsh research laboratories of the *Pennsylvania Salt Mfg. Co.* at Whitemarsh, Pa. were dedicated on Oct. 4. In a ceremony the key to the laboratories was presented to Dr. S. C. Ogburn, Jr., manager of research and development and head of the laboratories. The building has been converted from Whitemarsh Hall, the stately mansion of the late Edward T. Stotesbury. The extensive grounds will be maintained, famous for their magnificence and known as the "Versailles of America."

Following the recent announcement by *American Car & Foundry Co.* that $1,500,000 was being expended for expansion of its St. Charles, Mo. passenger carbuilding plant comes the statement that steel and aluminum have been released by WPB for construction of 55 cars for various railroads.

"Lukens Plate," employee publication of *Lukens Steel Co.* and its divisions at Coatesville, Pa., has been adjudged by the *Direct Mail Advertising Assn.* as one of 55 "direct mail leaders" in the "1944 Value-to-the-War-Effort" contest, with emphasis on how it takes news of Lukens to former employees in the armed services.

An automobile which will "depart from the conventional design and utilize plastics, light metals and other recent developments" will be produced by *Graham-Paige*

FERRISUL



"so easy on the draw!"

A. Carry lubricant into the die by etching.

Etching before drawing steel has become standard practice among many leading manufacturers. The reason: microscopic examination shows that the tiny peaks and valleys of the etched surface provides space for the distribution and retention of lubricating agents, which is not the case with slick, mirror-like surfaces.

Thus in the drawing operation, the pre-etched surface, by carrying the lubricant into the die:

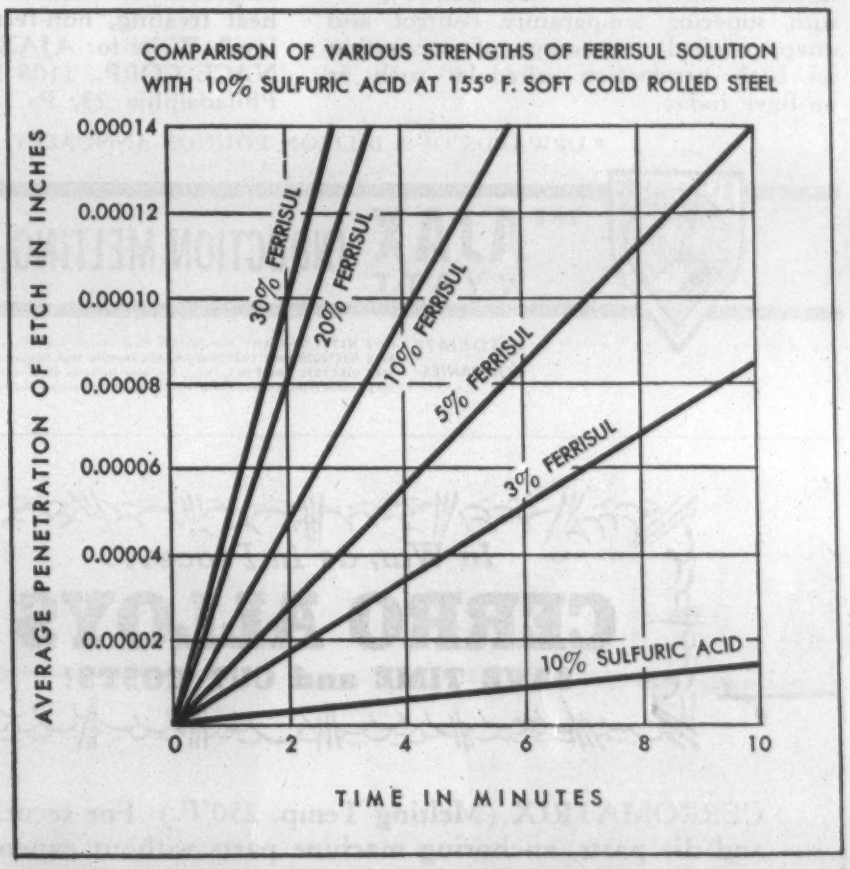
1. eliminates the scuffing which may occur with the poorly lubricated smooth surface
2. reduces friction and lengthens the life of the die
3. cuts down the power required for a given draw

This principle has application to all drawing operations of steel tubing, of wire, of cooking utensils, of stampings. In fact, wherever the area of any steel object is increased by drawing, a pre-etched surface is indicated for the better lubrication it provides and the easier, more uniform draw resulting.

B. Quicker, safer etch with Ferrisul.

Preference for Ferrisul for etching is based on these major advantages:

1. Unlike the etching acids, Ferrisul does not liberate hydrogen, hence there is no danger of embrittlement of the steel due to the inclusion of hydrogen.
2. Ferrisul has no acid fumes; it is also easy and safe to handle and store.



3. Action of Ferrisul on steel is extremely rapid, resulting in a fine-grained, uniform etch. The speed of the etch runs up to thirty times that of 10% sulfuric acid.

C. For full details on Ferrisul, for pickling as well as etching metals, or for special information relating to your processes, write, wire or phone, MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston 49, Mass.

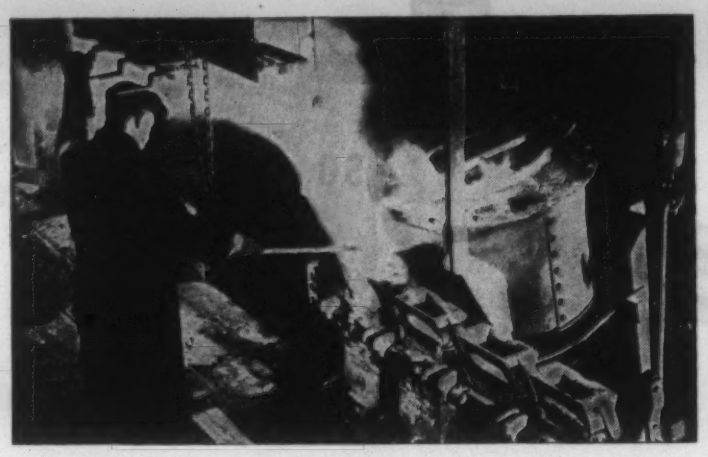
NOTE: *Ferrisul may also be used as an etching agent prior to painting, plating or galvanizing.*

MONSANTO CHEMICALS

SERVING INDUSTRY...WHICH SERVES MANKIND

HOW THE WROUGHT BRASS INDUSTRY CONSERVES METAL

No industry melting *commensurate tonnage of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:**



Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field — less than 1% — with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

Do you have your copy of "AJAX-METELECTRIC PROGRESS," the news magazine of induction melting, electric heat treating, non-ferrous ingot and alloys? Write to: AJAX ELECTRIC FURNACE CORP., 1108 Frankford Avenue, Philadelphia 23, Pa.

*** UPWARDS OF 5 BILLION POUNDS ANNUALLY**

THE AJAX WYATT INDUCTION MELTING FURNACE

ASSOCIATE COMPANIES: AJAX METAL COMPANY, *Non-Ferrous Ingot Metals and Alloys for Foundry Use*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup High Frequency Induction Furnaces*
AJAX ELECTRIC COMPANY, INC., *The Ajax-Hultgren Electric Salt Bath Furnace*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces*

In War, as in Peace...

CERRO ALLOYS

SAVE TIME and CUT COSTS!

CERROMATRIX (Melting Temp. 250°F.) For securing punch and die parts, anchoring machine parts without expensive drive fits, short run forming dies and other metal-working applications.

CERROBEND (Melting Temp. 158°F.) Used as a filler in bending thin-walled tubing to small radii. Easily removed in boiling water. Also used for aircraft assembly jigs, templates for forming dies and other purposes.

CERROSAFE (Melting Temp. 190°F.) Used to accurately proof-cast cavities such as molds, gun chambers, forging dies, etc., and for many similar applications.

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CERRO DE PASCO COPPER CORPORATION

40 WALL STREET NEW YORK 5, N. Y.

Motors Corp. upon its re-entry into the auto manufacturing field, according to its chairman, Joseph W. Frazer. It will be an "automobile years ahead of its time—a completely new car from the ground up. We plan to have the first real post-war automobile. We expect it to be as modern as tomorrow."

Analyzing the importance of research in the pre-war period, Dr. Cole Coolidge, assistant chemical director, *duPont*, states that in 1942 nearly half of duPont's gross sales consisted of products that either did not exist in 1928, or were not then manufactured commercially.

The DoAll Trade School of the *DoAll Co.*, with a record of over 2,000 trainee placements, has moved from Minneapolis to new and larger quarters in Des Plaines, Ill., Chicago suburb.

House Organ Notes

Profilometer Comments, Physicist Research Co., Ann Arbor, Mich. Vol. 2, No. 1.

This is a new publication, as to its revised form, appearing bi-monthly, whereas its predecessor came out irregularly. It is designed to offer "kinks" and ideas on the use of the Profilometer.

Nickelsworth, International Nickel Co., Fourth Quarter, 1944.

"Electronically-controlled welding is responsible for the fine seams on tiny refrigerant-line filters, fabricated from 0.0021 in., 200 Mesh Monel wire cloth by C. O. Jelliff Mfg. Corp. Monel's suitability for this delicate type of precision welding makes easier the task of constructing these little elements to the 0.001-in. tolerances needed in filtering impurities from corrosive refrigerant liquids."

Bakelite Review, Bakelite Corp., October, 1944.

To keep armed forces overseas informed on U. S. and world news events, the Office of War Information has tried many methods of sending the boys *Time* Magazine. At length they finally hit upon making Bakelite plastic plates of the *Time* pages, shipping the plates abroad and printing the magazines overseas. Plastic plates are much lighter than metal plates and can easily be shipped by airplane. They package easily, are hard to scratch or damage, and they print clearly and legibly, even on inferior paper and with inferior inks. Today Process Color Plate Co. of Chicago produces a Bakelite phenolic matrix directly from the type form from which domestic plates for *Time* are made. From this matrix are struck sets of "Vinylite" plastic plates which are flown to the corners of the earth. The plate package weighs 30 lb.

Modern Precision, Leeds & Northrup Co., Vol. 4, No. 1.

The instrument most commonly used by

TOOL STEELS

Midvale tool steels come from the school of hard knocks. They are the outcome of shop experience in making our own tools for some of the toughest machining jobs in all industry. The No. 1 Lesson is right steel. To get it in each case, we piled research on research, test on test. Result is a full Midvale line of modern tool steels, available for ready delivery on priority orders.

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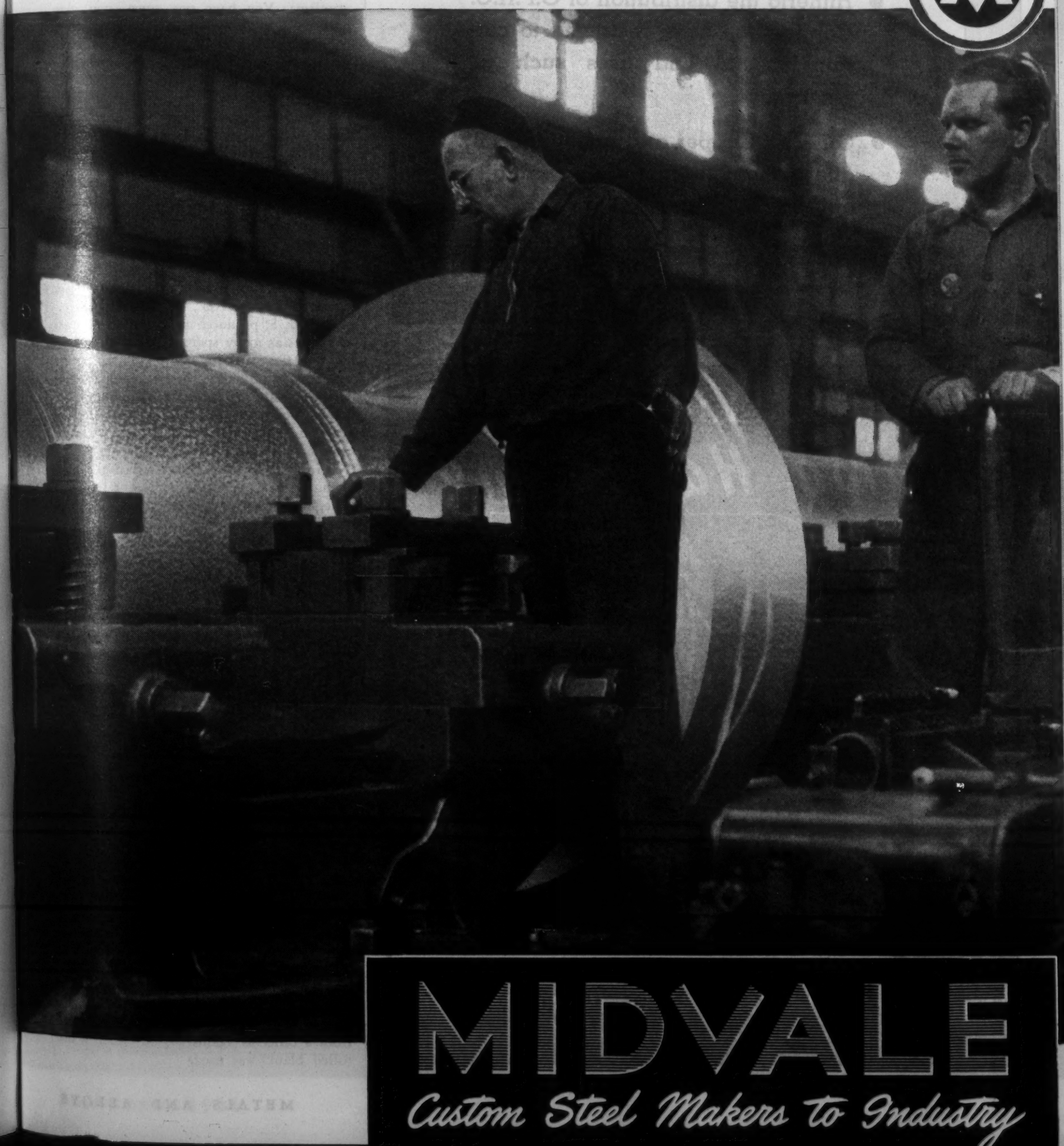

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Custom Steel Makers to Industry

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- Hitherto the distribution of O.F.H.C. Copper has been restricted to certain special end uses such as electronics.
- O.F.H.C. Copper and a few special dilute alloys thereof are now available for most uses.

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61 Broadway, New York, N. Y.

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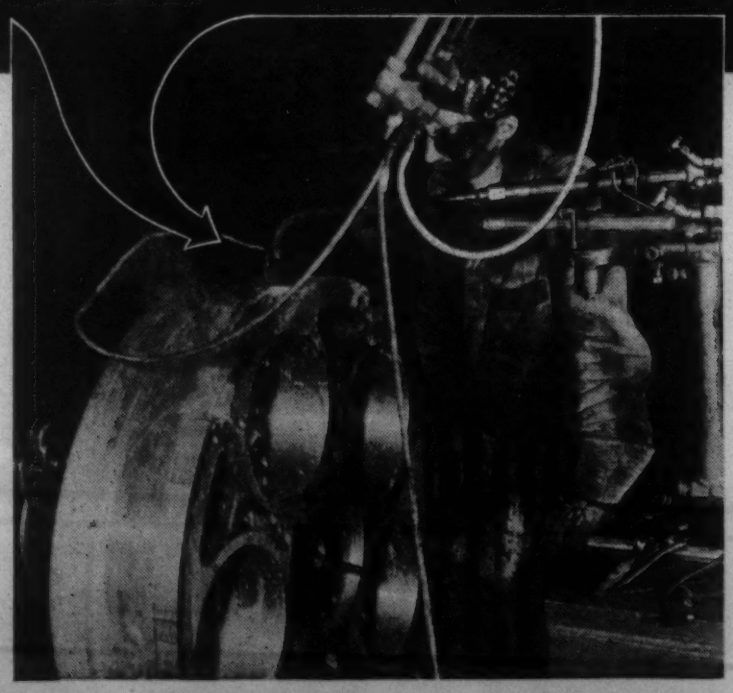

Flame Hardening
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Chapmanizing
Nitriding
Cyaniding
Tempering
Sand Blasting

Bar Stock Treating and Straightening
Physical, Tensile and Bend Tests

METAL TREATING INSTITUTE

THE LAKESIDE STEEL IMPROVEMENT CO.
5418 Lakeside Avenue CLEVELAND, OHIO Phone Henderson 9100

Benjamin Franklin to produce electric shocks was the earliest form of condenser, the Leyden jar. Its discovery was precipitated when Pieter van Musschenbrock of Leyden grasped a water-filled body connected to a friction machine and was flung across the room. A Leeds & Northrup capacitor has a capacitance 350 times as great as Franklin's 2-quart jar. L.&N. uses mica where Franklin used glass—mica with the same dielectric constant of 6, which glass has, but with a power factor of 0.0001, compared with 0.0034 for glass. L.&N. uses tin foil, machine-made to utmost uniformity, in place of beaten lead.

Inspiration News, Inspiration Consolidated Copper Co., Oct. 30, 1944.

Form of Government (Take Your Choice). Socialism: You have two cows—you give one to your neighbor. Communism: You have two cows—you give both cows to the government, which gives you part of the milk. Facism: You have two cows—you keep both cows and give the milk to the government which lets you buy part of it back. Nazism: You have two cows—the government shoots you and takes the cows and sells the milk. American New Deal: You have two cows—the government shoots one cow, buys the milk from the other cow, and pours it down the sewer. Capitalism: You have two cows—you sell one and buy a bull. Social Credit: You shoot the bull.

Firepower—The Ordnanceman's Journal, Army Ordnance Assn., October, 1944.

The U. S. produces and supplies at least ten times as many spare parts for ordnance as the Germans to maintain the same amount of ordnance as the Nazis due to lack of standardization and distance between production and fighting fronts. Hitler compelled his Reich to use military trucks in peace, costly in peacetime but "paying off" in war. Hitler forced all truck manufacturers to make parts interchangeable, with variety of models cut to a bare few. The U. S. had 135 producers of trucks, with difference in models and interchangeability. Today the same medium U. S. tank is powered by four different kinds of engines. Complicating the situation is the abuse of parts by certain Allies. Thus, the French sometimes put wine, instead of water, into batteries, figuring that if wine rejuvenates humans, why not batteries?

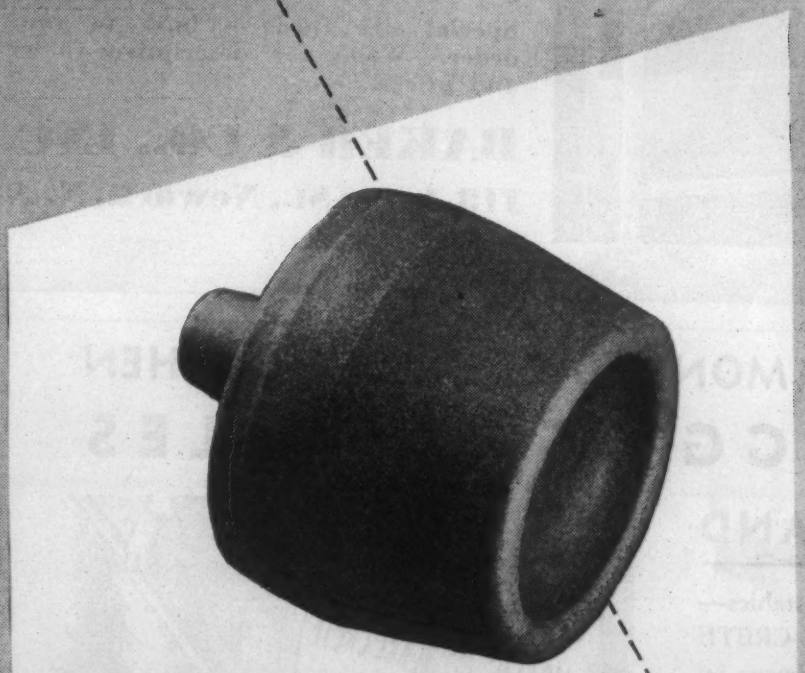
Republic Goes to War, Republic Steel Corp. From 1939 to Sept. 1944.

Demands for electric furnace steel became greater than industry could meet. Early in 1941 Republic changed from electric furnace steel to high quality open hearth steels for gun barrels. Since then millions have been equipped with rifles from this newly developed steel. Since then the Buffalo district has produced many million gun barrels, representing over 41,000 tons of steel. Savings in tool cost and machine time were enormous and production upped 40% by using these die rolled blanks. The same facilities were used for other products such as truck forks. A fork section formerly needed 2½ hr. to forge from a billet as against ½ hr. when a die rolled blank was used.

T&W FORGINGS

usually cost less at the point of assembly

A correctly proportioned combination of physical properties, plus uniformity of physical properties, both of which are obtainable in forgings, may be a vital factor in meeting post-war competitive conditions, because the element of time involved in forming parts will be of even greater moment than it is today. Hot working metal in closed impression dies, as in the forging process, like heat treating, should be and usually is a straightforward production procedure that is controllable at every stage. The reduction of rejections and checking time made possible by the fact that in forgings you can obtain metal quality in the exact degree desired, will provide you with an important cost advantage. With T & W forgings you can realize the utmost of this advantage, because T & W forgings *usually cost less at the point of assembly.* Ask a T & W Forging Engineer to help you obtain the full benefits which forgings offer.



This simple shaped design requires close control of temperature and forging operations, because the entire section of this forging must be free of all concealed defects—sound throughout—to withstand unrelenting vibration and fatigue stresses.

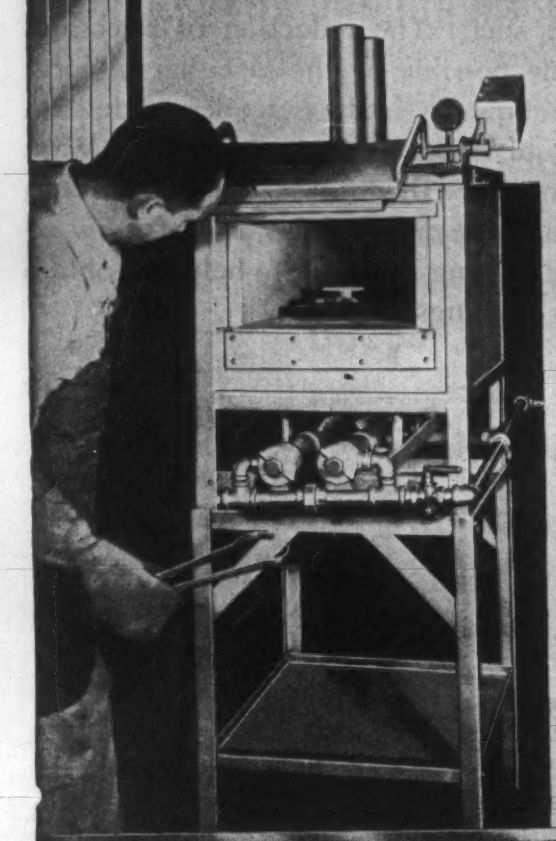
TRANSUE & WILLIAMS

STEEL FORGING CORPORATION • ALLIANCE, O.

SALES OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, INDIANAPOLIS, DETROIT AND CLEVELAND

Baker Gas Furnaces

TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.

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TIME AND MONEY ARE S-A-V-E-D WHEN KELLOGG CASTABLES ARE ON HAND

Users of Kellogg Castables—KASTIC and KEL-CRETE reduce furnace shut downs by making their own special shapes, jambs, door linings, baffle walls, ducts, dampers, car tops, etc. by simply adding water to the scientifically prepared Kellogg mixture. No waiting for delivery of special shapes from a distant point.

KASTIC...

KASTIC prepared in two grades—Industrial and Domestic; both with a maximum working temperature of 2600°F.

KEL-CRETE...

KEL-CRETE is light in weight—60-65 pounds per cubic foot with a maximum working temperature of 2000°F.

Write today for bulletins giving information on these products.

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Aluminum Progress, Reynolds Metals Co., November 1944.

"After nearly two years of laboratory tests and development of fabricating processes, the strongest aluminum alloy yet available for commercial use was recently announced by Paul P. Zeigler, our chief metallurgist. Known as R-303, it is made with magnesium, zinc and copper. It has almost three times the compressive strength of structural steel, is over 50% stronger than structural steel in tensile yield strength and 70% stronger than older type high-strength aluminum alloys. When peace comes, it will be useful for railroad equipment, automotive parts, heavy machinery and light household articles."

Briefs on Associations, Promotions and Education

An attractive illustrated 22-page pamphlet has been issued in behalf of the "Light Metals Research" program at the State College of Washington, Pullman, Wash. It outlines its many facilities and personnel for developments in magnesium and aluminum from ore to finished product. They describe this light metals research center as the "Inland Empire of the Pacific Northwest." The U. S. Bureau of Mines has an experimental station there also. Eri B. Parker is executive secretary of the Light Metals Advisory Committee.

The 1945 congress of the American Foundrymen's Assn., its 49th annual meeting, will be held in Detroit the week of April 30 to May 4. The key note will stress the necessity of continued high production by the foundry industry, even though V-E Day may precede the foundry convention. Arrangements will be made for visiting Detroit foundries. The third A.F.A. Foundation lecture will be given by Dr. H. A. Schwartz, research manager, National Malleable and Steel Castings Co., Cleveland, on "Solidification of Cast Metals." No exhibit is planned.

An advisory committee to the National Roster of Scientific and Specialized Personnel of the War Manpower Commission has been named by Paul V. McNutt to advise on the utilization of technically trained men and women in the war effort. Members of the committee include William L. Batt, vice chairman, WPB, who is on leave as president of SKF Industries; Dr. Vannevar Bush, director, Office of Scientific Research and Development and president, Carnegie Institution of Washington; Dr. Edward C. Elliott, president, Purdue University; Dr. Frank B. Jewett, Short Hills, N. J., president, National Academy of Sciences and vice president, American Telephone and Telegraph Co.; Dr. Waldo G. Leland, Newton, Mass., director, American Council of Learned Societies; Paul Webbink, Washington, D. C., Social Science Research Council; and Dr. Leonard Carmichael, president, Tufts College and until recently, director, National Roster.

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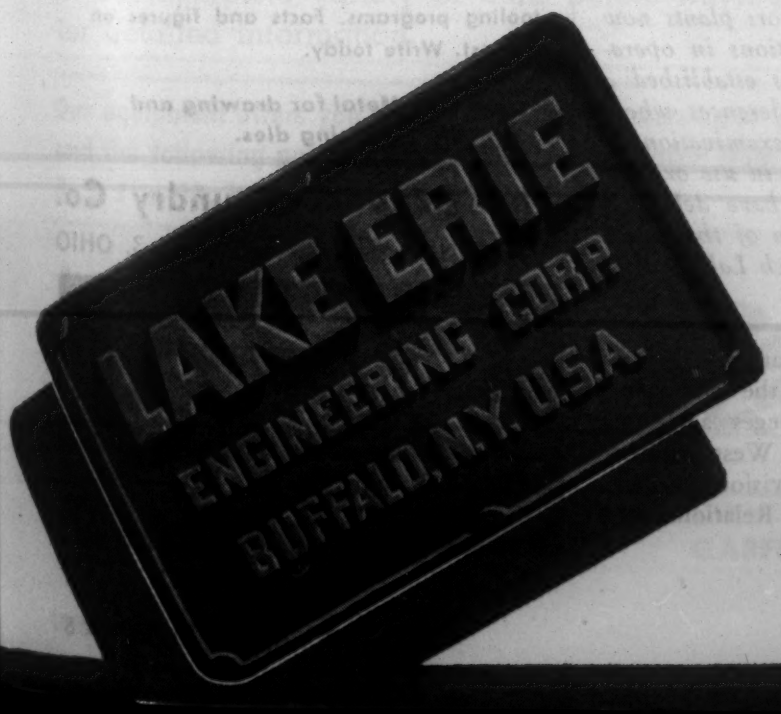
. . . Such As You've Never Imagined!



—a press big enough to stamp out machinery to move mountains—or small enough to make the finest, most sensitive equipment. LAKE ERIE specializes in making machinery to meet your own design and demands. Lake Erie knows you expect outstanding performance from your equipment. Consequently, Lake Erie makes rugged precision Hydraulic Presses and special machinery. Lake Erie-made machines can "dish it out" at remarkable speed and accuracy—and Lake Erie equipment can also "take it", can stand up under years of tough, gruelling wear. Remember Lake Erie when you want custom-made machinery or dependable Hydraulic Presses of any dimensions.

LAKE ERIE ENGINEERING CORP., BUFFALO 17, NEW YORK

District representatives: 250 Park Avenue, New York 17, N. Y.; 230 North Michigan Avenue, Chicago 1, Illinois; Harron, Rickard and McCone, San Francisco and Los Angeles, California; Buck & Hickman, London, England.

FURNACE PURGING

HERE'S how simple it is: Measure specific gravity of generator gas with the Ranarex* instrument. Then continue purge until specific gravity is the same at the furnace outlet as it is at the inlet. Then you're *sure* there's no air in the gas. Danger of explosion is reduced and there's no need for extra purging time as a safety margin.

Ranarex is a sturdy instrument, containing no chemicals or fragile parts, easy to operate. Write for free bulletin to The Permutit Co., Dept. A17, 330 W. 42nd St., New York 18, N. Y. or Permutit Company of Canada, Ltd., Montreal. *Trademark Reg. U. S. Pat. Off.

WITH—

RANAREX

PRODUCT OF
PERMUTIT

Brazil, and certain other South American countries, now have laws limiting the practice of engineering to graduates of their own schools, thus debarring aliens. This was brought out at a dinner to Dr. A. Allan Bates of Westinghouse, Prof. Arthur Phillips of Yale and Dr. Robert Mehl of Carnegie Institute—all metallurgists—who have returned after lecturing on metallurgy at the University of Sao Paulo in Brazil. Brazil's bottleneck is a lack of technically trained men. Some plants operate antiquated equipment, to be replaced at war's end.

The Metal Treating Institute, a national organization of commercial heat treaters, re-elected Horace C. Knerr, Metlab Co., Philadelphia, as president at its 12th annual meeting at Cleveland.

The American Society of Tool Engineers has established its national office in the Penobscot Bldg., Detroit 26. Membership is now over 16,000. The new offices will house the editorial staff of the "Tool Engineer," official journal of the society, publishing this journal under its own auspices after ten years of publication by an outside contractor.

The American Die Casting Institute, Inc., has received the Distinguished Service Award from the U. S. Ordnance Dept. The secretary points out that the Institute is not a technical society, but rather a trade association of manufacturers—hence it is unique to be thus recognized for scientific and engineering accomplishments.

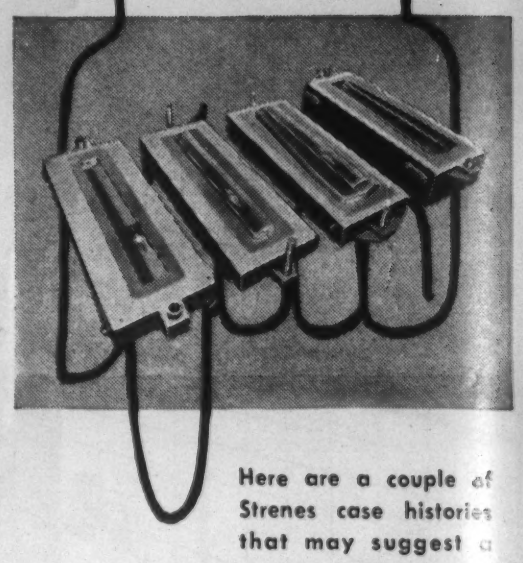
Thirty Chinese Nationals, all graduate engineers, are to be given a year's training in production work and specialized occupations at the Lycoming Div., Aviation Corp., at Williamsport, Pa. After a year the group will return to China to supervise manufacture and assembly of Lycoming engines there.

The Henry Marion Howe medal of the American Society for Metals has been awarded to three staff members of the American Brake Shoe Co.'s metallurgical laboratory at Mahwah, N. J.; Earnshaw Cook, chief metallurgist; J. A. Fellows, assistant chief metallurgist, and R. A. Flinn, assistant metallurgist. The award was for the best paper appearing in A.S.M.'s publication, "Transactions."

Twenty-four General Motors plants now have spectrographic installations in operation or on order. G.M. has established a series of spectrographic conferences where are held frank and critical examination of spectrographic methods now in use or contemplated. Several experts have delivered papers. Temporary chairman of the group is G. M. Rassweiler, Research Laboratories Div.

Formation of a new Educational Department, coordinating all of the company's relations with schools, colleges and universities, is announced by Westinghouse. It comprises three main divisions, called: School Service, University Relations and Student Training.

STRENES METAL POINTS THE WAY



Here are a couple of Strenes case histories that may suggest a way to reconvert to civilian production a little faster.

Tractor Top-Dies

Strenes Metal—cast-to-shape—was specified for stamping tractor hood tops. An accurate cost check showed a saving of around 50% in machining time due to the cast-to-shape construction. On reconversion tooling rush, such a saving will be highly advantageous.

Hydrator Pan Die

Dies of Strenes Metal stand up, too. One refrigerator hydrator pan die, for instance, stamped 2,000,000 parts with a 3½" draw out of .50 material. And, due to the self-lubricating property of the metal, stoning and polishing operations were virtually unnecessary.

Both for civilian and war products, Strenes Metal has been a definite help on many tooling programs. Facts and figures on request. Write today.

Strenes Metal for drawing and forming dies.

The Advance Foundry Co.
100 PARNELL ST. DAYTON 3, OHIO

Strenes METAL

WARNING TO FIRST-TIME USERS . . . .

DON'T LOOK FOR A JACK-OF-ALL-TRADES IN ELECTRONIC HEATING MACHINES

ELECTRONIC HEATING is rapidly outmoding many industrial heating processes because of its numerous advantages, recognized and acknowledged by all leading industries.

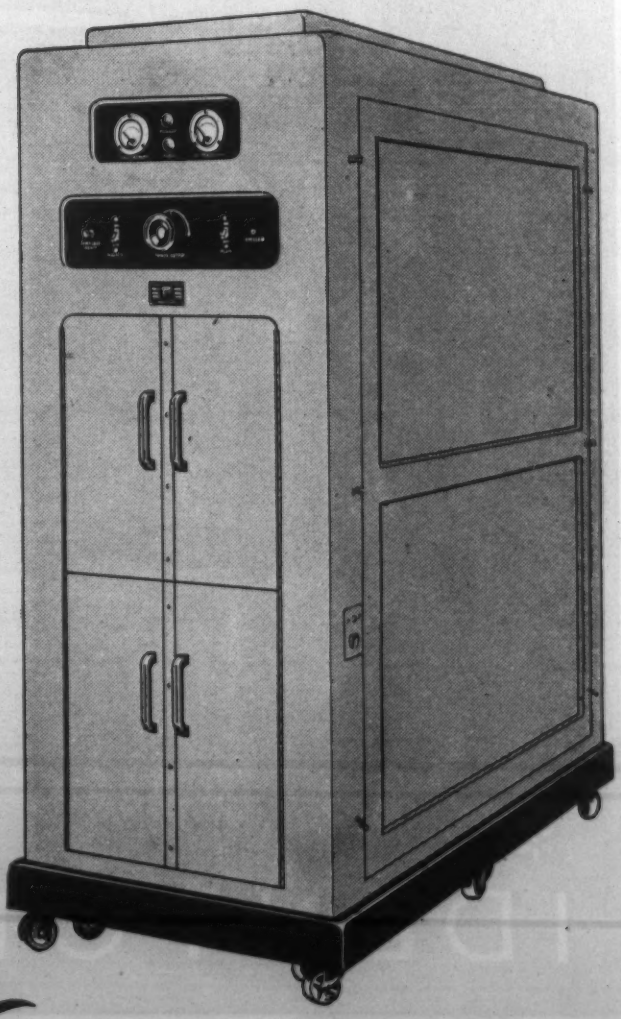
It is, however, important to realize that the maximum time-and-money-saving advantages of the process can only be realized by *using it correctly in every application.* Each heating process requires a definite FREQUENCY and POWER combination.

To use any combination of frequency and power other than the one ideally adjusted to the process implies a waste of power and the use of a "misfit" size machine.

No electronic heater has ever been built that can provide a large enough variety of frequency and power combinations to permit economical application to more than one type of heating operation.

For 23 years we have pioneered and specialized in electronic heating. As recognized experts we urge all first-time users to consult our engineers and to investigate the many advantages of our complete variety of units before buying. Write to us for detailed information.

Our equipment offers you a selection of frequencies up to 300 megacycles—and the following power range, with stepless control from zero to full load: 3, 5, 7½, 10, 12½, 15, 18, 25, 40 and 100 Kw.



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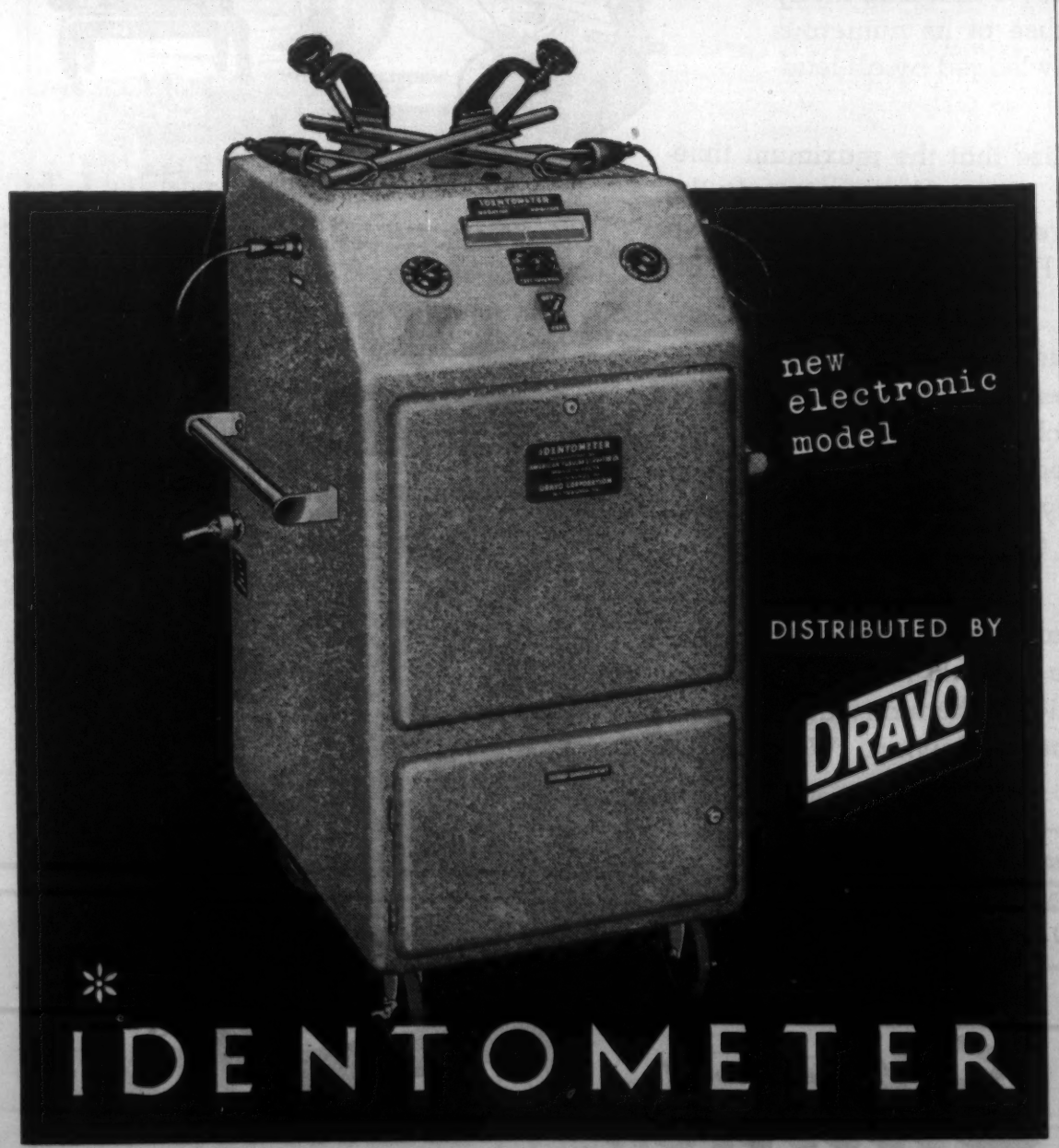
POSITIVE STEEL IDENTIFICATION

now faster!

On the new Identometer, equipped with an electronic timing device, most rolled or forged ferrous materials can be tested against known samples for positive quality control at speeds that will keep pace with modern shop tempo.

Identometer is used to sort steel stocks and to check material against specifications by comparing heats at any practical point during processing.

Read the whole story of this new metallurgical tool! —What it is and how it works is told in Bulletin 12A. Address—Dravo Corporation, National Department, 300 Penn Avenue, Pittsburgh 22, Pa.



AN ELECTRICAL INSTRUMENT FOR THE INSTANT AND ACCURATE IDENTIFICATION OF MOST ROLLED OR FORGED FERROUS ALLOYS BY THE USE OF REFERENCE SPECIMENS

A booklet has been issued, entitled "The War Metallurgy Committee—a Report of Its Purposes, Aims and Work." Appearing on the cover is "National Academy of Sciences, National Research Council." Chairman of the committee is Clyde Williams, director, Battelle Memorial Institute, Columbus, Ohio.

News of Engineers

Captain William F. Silsby, on military leave from Pittsburgh Lectromelt Furnace Corp., was recently awarded the Legion of Merit, the highest military honor conferred upon any member of the military service for outstanding non-combatant service. The citation reads: "For outstanding service as officer in charge of the Hawaiian Dept. and Central Pacific Area Searchlight Repair Shop." He was graduated from Carnegie Institute of Technology as metallurgical engineer.

The following appointments have been made by Allegheny Ludlum Steel Corp.: *Dr. Gurdon M. Butler* will be metallurgical engineer and associate director of the Research, Tool and Die Steel Div. *Dr. Gunther Mohling* becomes metallurgical engineer and associate director of Research, High Temperature Alloy and Valve Steel Div. *Dr. R. A. Lincoln* is now metallurgical engineer and associate director of Research, Stainless Steel Div. *George C. Kiefer* is made chemical engineer and associate director of Research, Corrosion and Coatings Div.

Five American engineers are going to China to help Donald M. Nelson improve China's war production. They are: *Herbert W. Graham,* director of metallurgy and research, Jones & Laughlin Steel Corp.; *Carl Albert Bell,* foundry superintendent, United Engineering & Foundry Co.; *Henrik Ovesen,* consulting engineer, Lukens Steel Co.; *Harry A. Strain,* director of war materials, fuel and tar, U. S. Steel Corp., and *E. K. Waldschmidt,* formerly of Jones & Laughlin Steel Corp., but now chief of the shell steel section, WPB steel division.

George Mast has joined Milwaukee Metal Spinning Co. as engineering and production supervisor, being concerned with coordination of production in the company's several plants. He has previously been in engineering work with several industrial companies.

Dr. Richard M. Hitchens has been promoted to associate director of Monsanto Chemical Co.'s organic chemicals division. He started with Monsanto in 1931, starting as research chemist, later becoming a research group leader.

John W. Sands, with the Conservation Div., WPB, since January 1942, has resumed his duties with the Development and Research Div., International Nickel Co., Inc. at New York.

Here's a Double-Duty Castable

that will save you money

Because KAST-O-LITE combines insulating properties with castable advantages—it provides monolithic linings or special shapes that cut fuel bills, reduce heat losses, and increase operating efficiency.

KAST-O-LITE is a castable refractory concrete with insulating properties and suitable for service at high temperatures in furnaces and other industrial heating units. It combines the advantages of light weight monolithic construction, low heat conductivity and high working temperature.

Now, you can have insulating furnace linings from a single package — double duty, easy-to-install castable.

A. P. GREEN
FIREBRICK COMPANY
A.P. GREEN — *the First Name in Refractories*
MEXICO, MISSOURI

the most AMAZING Castable Refractory in Engineering History!

QUICK DELIVERY—LOCAL STOCKS
Warehouse stocks of KAST-O-LITE are located near you for prompt delivery.

NEW! Nothing Like Kast-O-Lite

INSULATION FOR USE TO 2500° F. IN DIRECT CONTACT WITH FLAME

There is no other insulating castable like KAST-O-LITE. It's INSULATION plus CASTABLE for use in direct contact with flame to 2500° F. **DON'T CONFUSE THIS NEW ACHIEVEMENT IN CASTABLE INSULATING REFRACTORIES WITH GENERALLY OBTAINED CASTABLES FOR USE TO ONLY 1800° TO 2200° F.** KAST-O-LITE has a fireclay base—a high P.C.E—and like no other insulating castable, will withstand continued direct exposure to furnace gases at temperatures to 2500° F.

In All Types of Plants . . .

Plant men everywhere in all types of plants are praising the merits of KAST-O-LITE. R. B. Seger, General Superintendent of Lindberg Steel Treating Company of Chicago, said: "We have been using KAST-O-LITE for a long time to replace both heavy and light weight firebrick. Because this material combines both insulation and refractory qualities together with ease of installation, we find it is saving us money and doing an improved job."

FREE Data Book

A big 24-page factual book has just been prepared to tell you what KAST-O-LITE is, where it produces savings, and why it's the world's most amazing castable refractory. Mail the coupon below today for your free copy.

A. P. GREEN FIREBRICK COMPANY
Mexico, Missouri, U.S.A.

Please send me your helpful new book "A Guide to the Uses & Advantages of Insulating Refractory Castable."

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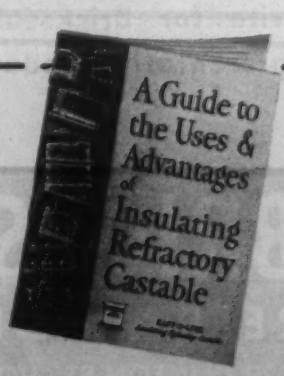
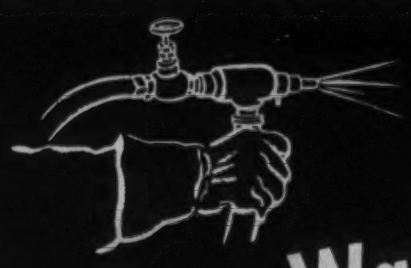


BRICKSEAL



An Easy Way to Conserve Refractories

1—*Paint or spray brickwork with BRICKSEAL.*
2—*Light fire. Furnace is ready for immediate production.*

Heat of furnace vitrifies Brickseal permanently into all pores, cracks and joints, forming a highly-glazed, monolithic coating, impervious to acids, alkalis, corrosive gases, flame abrasion and air infiltration.

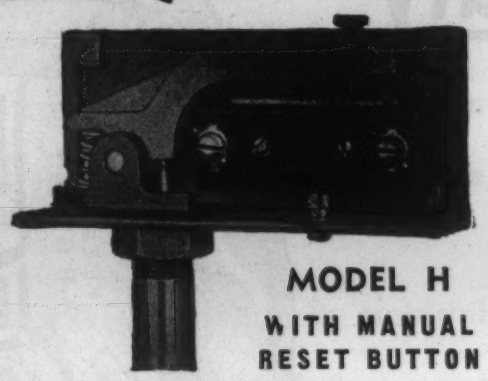
Brickseal will not crack or peel off due to sudden temperature changes, because it remains semi-plastic until the furnace cools. Brickseal prolongs the life of new or old refractories for a fraction of the cost of relining.

Write for Brickseal sample or representative, today.

BRICKSEAL
REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.

BURLING
TEMPERATURE LIMIT SWITCHES

USE NO LIQUIDS . . . NO GASES



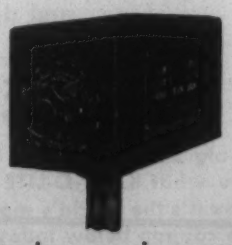
MODEL H
WITH MANUAL RESET BUTTON

Improved High Temperature Safety Switch with Manual Reset Button. Available with switch normally closed for cutting off heat, stopping fan, closing valve — with switch normally open for lighting lamp or ringing bell—with single pole double throw switch . . . breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside of case.

- Accurate, Rugged, Dependable
- Corrosion and heat resisting tube
- Dial Pointer for easy setting
- Locking screw locks temperature setting
- Terminal plate has large screw terminals
- Snap-action Micro-Switch eliminates contact troubles
- Range 0-1400°F. Adjustable range 200-300°F
- Dimensions—5⅛" x 1¾" x 3"

MODEL V-I

For lower temperature range from 0-300°F. Available for minimum of —100° to maximum of 600°F. Usual adjustable range 50-150°, operating differential may be as small as ±¼ or as large as ±5°. Adjustable by screw and dial inside case. (Sizes 2¾" diameter × 4¼" high)



MODEL D

Adjustable range 200-500°F. Temperature range 0-1400°F. For use where temperature must be changed to suit operating conditions. Turn outside knob to change temperature setting. (Sizes 5½ x 2¾ x 2¾").

Instruments also Built to Specifications

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THE RITE PRODUCTS

are always the right products

FOR CLEAN STEEL

AND INCREASED PRODUCTION

LUNKE-RITE — an extremely effective exothermic, powdered compound for the control of piping in steel ingots poured *with or without*, hot tops; and in steel castings. It increases ingot yield considerably. The additional heat created has a beneficial effect on quality of steel by reducing rate of cooling in center section of ingot, which has been found to prevent internal cracks and laminations. This fact is especially important for large forging ingots.—Also used for fitting ladle stopper into nozzle;—as covering of nozzle and stopper head, which, as several plants claim, eliminate any dripping during the pouring;—as cover on steel in ladle where duplexing or reladling is practiced;—as cover on hot metal being transported a distance from blast furnaces.

A grade of LUNKE-RITE for every need.

RITE-MELT CLEANSER — a strongly effective powdered compound, containing no aluminum, placed on bottom of ladle just before tapping heat; or into stream as soon as it begins to flow into ladle; preferably on bottom of mold, thereby gaining greater advantage by preventing stool-stickers.

RITE-SULPHUR REDUCER — put on bottom of ladle just before tapping heat; or into stream as soon as it begins to flow into ladle. Reduction according to original content of Sulphur.

CONRAD WOLFF

Manufacturer—Owner of
THE RITE-PRODUCTS CO.
Irvington 11, N. J.

Additional Products:

RITE-TONERDE — finest levigated alumina.
GREEN-ROUGE POLISH—levigated chromic oxide.
MILD POLISH—levigated tin oxide.
SHARP POLISH—levigated cerium oxide.

P. O. BOX 448 NEWARK 1, N. J.

Extra Cost: *a Few Cents* . . Possible Savings: $23.00

Think of a 7-ton airplane diving faster than the speed of sound—and the tremendous strains exerted as the pilot pulls out of his dive.

Here is the hinge that holds the wings to the fuselage of one of our champion heavyweight fighting planes—the P-47 Thunderbolt. And it's made from Republic Electric Furnace Steel.

This fine steel has all of the strength, toughness and fatigue resistance needed to provide a high factor of safety. But more, it prevents lost time and money in production.

Steels made in Republic Electric Furnaces are as CLEAN and SOUND as the most expert furnace practice can make them. They are free from imperfections which might cause rejection at final inspection and the irrecoverable loss of all the time and labor expended.

This wing hinge, made from a 3 1/16" bar that costs about $2.00, has a final value of $25.00. Thus, the few extra cents spent for electric furnace quality is low-cost insurance against the loss of some $23.00 in production cost.

Republic Electric Furnace Steels enable manufacturers to derive greatest benefits from mass production methods—because they are consistently UNIFORM, homogeneous and free from practice-upsetting variables.

They hit narrowest physical, chemical, hardenability and workability specification marks repeatedly—because they are "targeted" by the close control possible only in the electric furnace.

And they can help you improve product quality or cut costs—help you prepare for keenly competitive markets. Republic—world leader in electric furnace steels—is ready to tell you how. Write us.

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REPUBLIC

—Leader in the Production of

ELECTRIC FURNACE STEELS

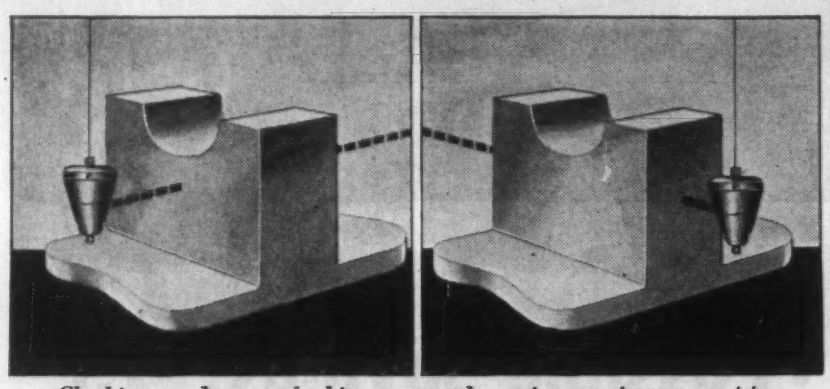
"QUALITY" steels . . . alloy . . . stainless

CANADIAN RADIUM IN MODERN INDUSTRY

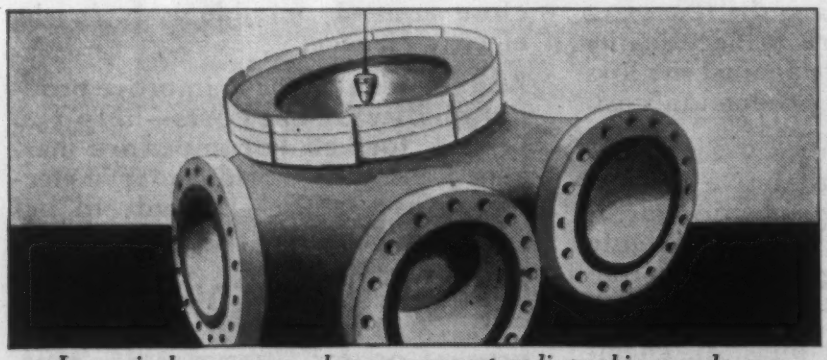
EASY WAY TO DETECT INTERNAL FLAWS

CANADIAN RADIUM SAVES

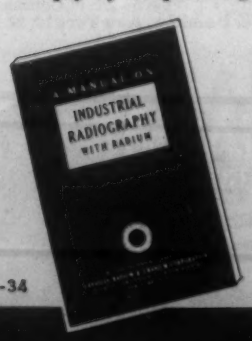
TIME, LABOR, MATERIALS —INSURES SOUND PRODUCTION



Checking and cross-checking a metal section to insure positive detection of flaws, such as tight cracks, is easy with radium. Its Gamma-rays penetrate up to 10 inches of solid steel.



In a single exposure, clear, permanent radiographic records are made through critical areas on both sides of a ponderous casting, simply by suspending a radium capsule inside the aperture.



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Reliable, profusely illustrated 80-page textbook on the fundamentals and technique of modern Industrial Radiography of Metals with Radium. Specially prepared for the metals industry by our research and technical staff. Write for your copy today, giving your name and company position.

R-34

CANADIAN RADIUM & URANIUM CORPORATION

630 FIFTH AVE., ROCKEFELLER CENTER, NEW YORK 20, N.Y.

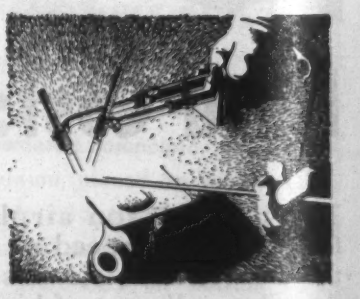
New 9000° Arc Torch can be used for Welding and Brazing all Ferrous and Non-Ferrous Metals and Alloys

Now an arc torch that makes it possible to do most jobs *electrically* that previously were thought possible only with gas. This attachment for arc welders provides an independent source of heat by means of two carbons. It is capable of producing intense heat, approximately 9000° F., over 2000° hotter than an oxyacetylene flame. Pure heat, no oxygen or gas to contaminate the weld. No pressure to force the molten metal away or blow holes in light sections.

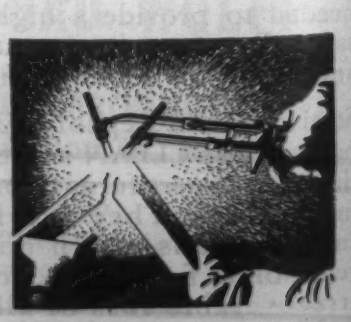
Developed to capitalize to the fullest on the time-saving advantages of electric welding, the new Mid-States 9000° arc torch can be used with any AC or DC electric welder. It opens up new horizons of service in this field, never before possible with an electrically operated instrument.

New uses are being found every day for products that have been familiar to us for years. Wrigley's Spearmint Gum, always enjoyed for its chewing satisfaction, is now proving with the fighting men overseas many benefits which will be useful to you in peacetime. One of the big factors in mass production is the alertness and efficiency of the man on the job. The chewing of Wrigley's Spearmint will help keep you alert and wide-awake during those work periods that, while seemingly dull and monotonous, call for watchfulness in order to get perfection in the final assembly.

You can get complete information from Mid-States Equipment Co., 2429 So. Michigan Avenue, Chicago 16, Illinois

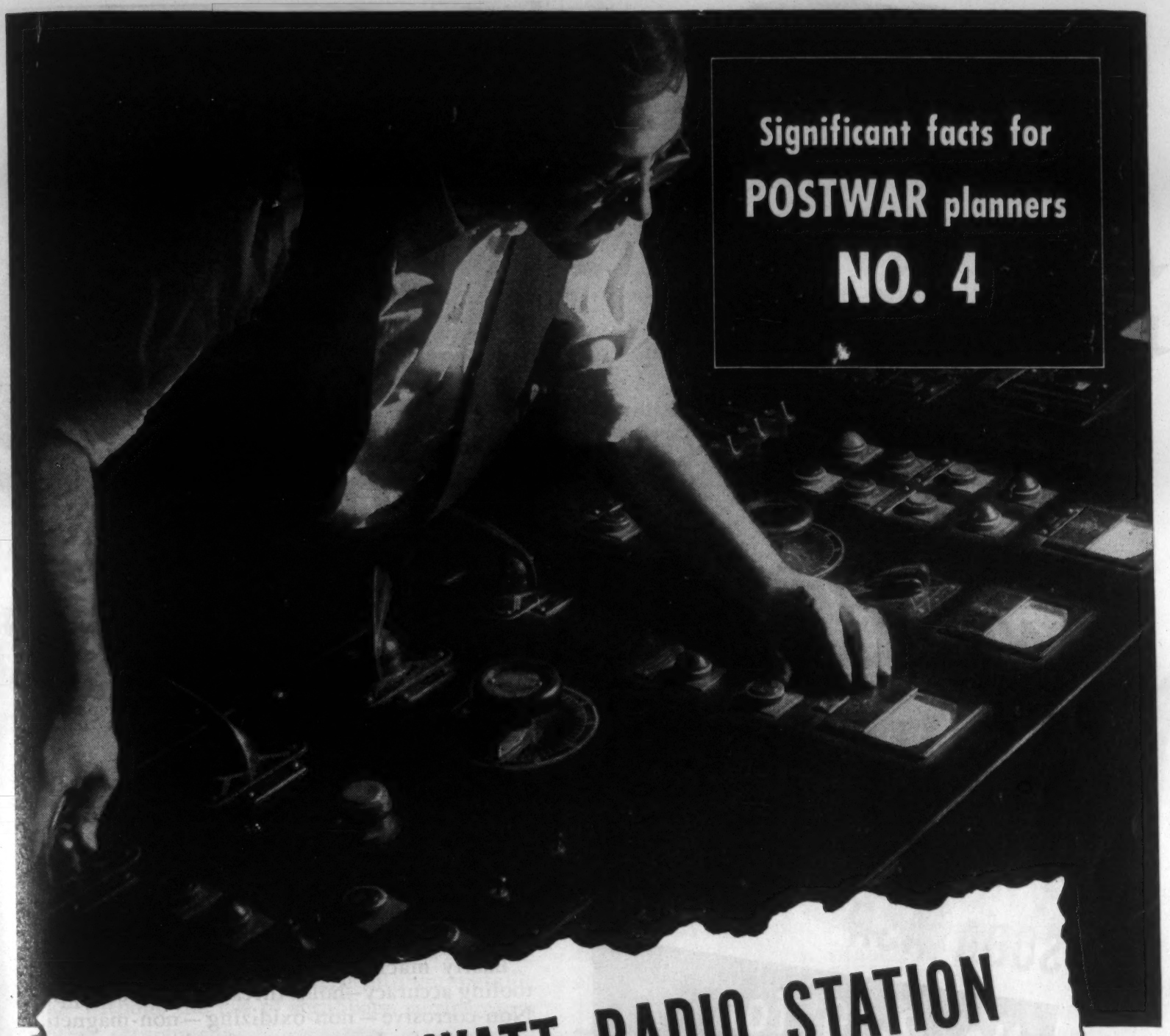


For BRAZING Steel, Cast Iron, Malleable Iron, Copper, Brass, Bronze, and other ferrous and non-ferrous metals.



For HEATING to Straighten or Bend, etc.

ADV- Y-166



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Through constant research for new ways to make things better, Granite City Tin Plate is now made by the electrolytic method. Equipment capable of generating 400,000 watts of high frequency radio energy fuses and brightens the tin coating faster and better. The more uniform and accurate control provides a superior surface for subsequent manufacture. By this method, tin plate can be supplied in sheets or coils for postwar production—just as you prefer.

This improved tin plate is significant of the many Granite City developments which mean better steel products for postwar planners. If your ideas for the future are stumped by the need of a special kind of steel, write or contact our nearest branch office.

If you are looking to the future, keep your eye on Granite City Steel

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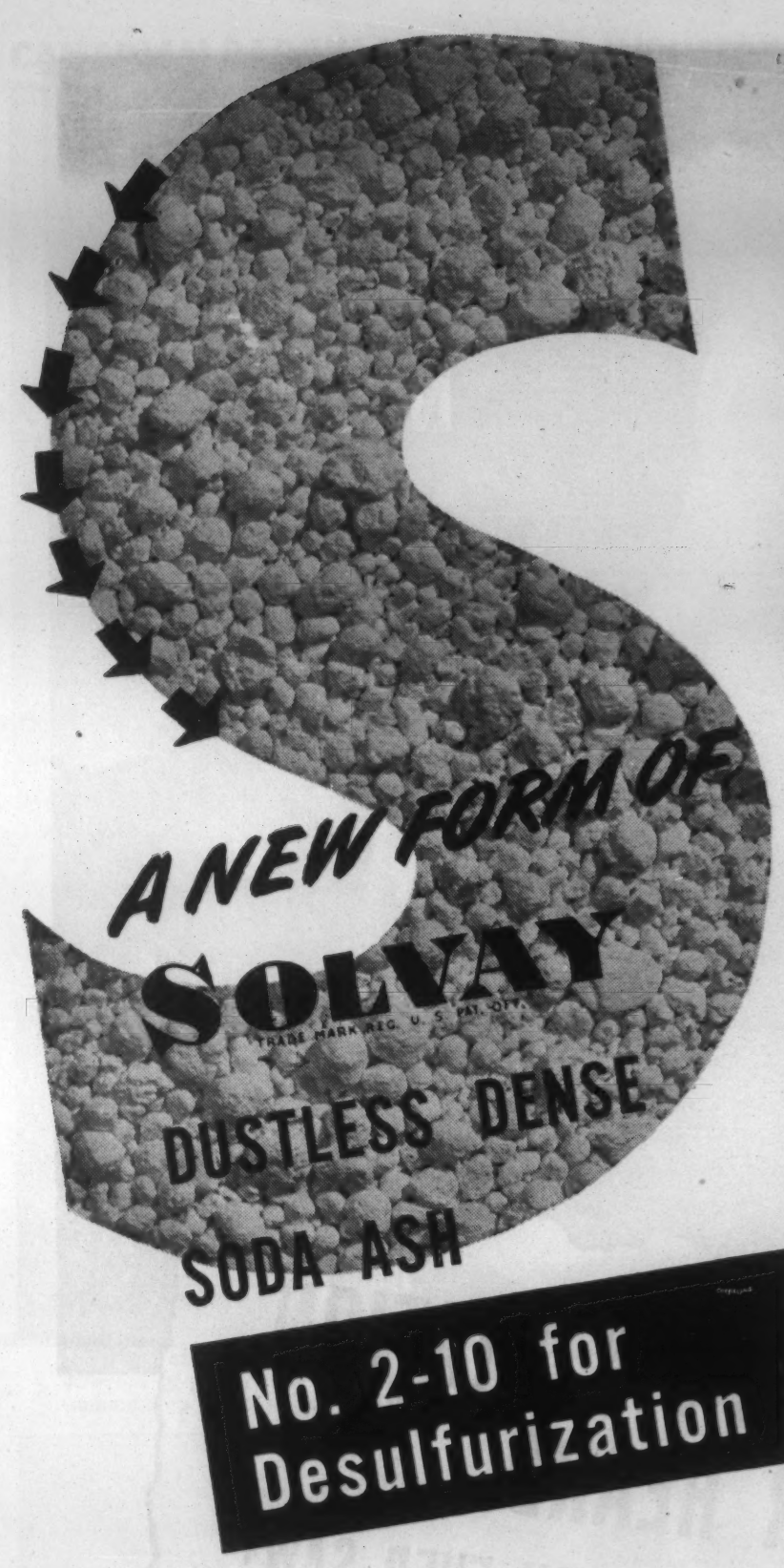

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Especially prepared for desulfurization is this new form of SOLVAY Dustless Dense SODA ASH No. 2-10. It's granular.

The proper application of No. 2-10 will permit lower slag volume with consequent savings, and at the same time control sulfur.

Immediate delivery of No. 2-10 can be made. *Inquiries are invited.*

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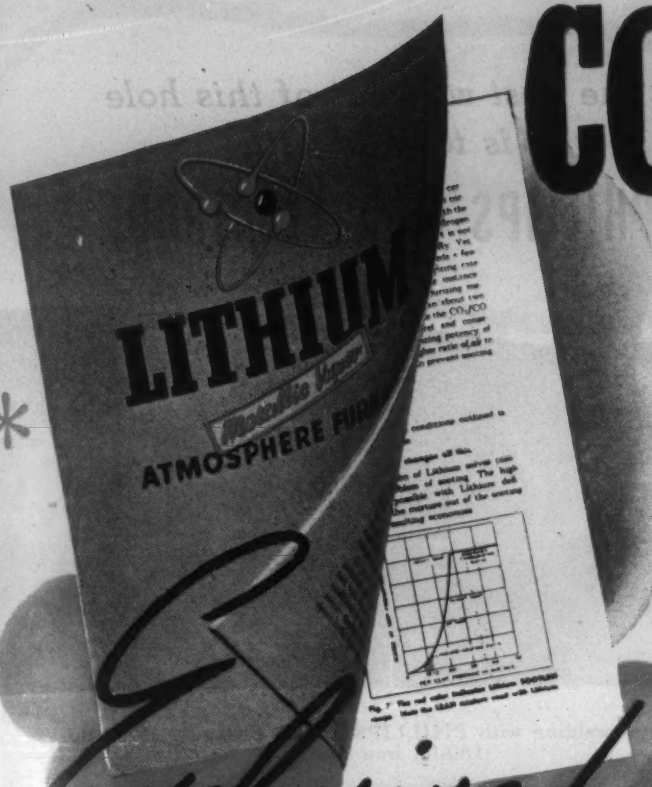

CONTROL . . . AT THE WORK

Exclusive feature of the LITHIUM PROCESS

In the Lithium Process the CONTROL is active Lithium vapor itself . . . produced *inside* the furnace simultaneously with a low-cost combustion gas—the two blended into one atmosphere which is kept permanently inert by the Lithium metallic vapor without the use of scrubbers, refrigerators or other attachments.

This simple procedure places the *control* inside the furnace *at the work* where it belongs . . . and then automatically continues that control throughout the heating period up to the very moment the steel is removed. The costs and adjustment problems of critical controls, pre-drying equipment and its supervision do not exist in the Lithium Process.

When any pre-dried atmosphere enters a furnace muffle, it immediately becomes wet again by water vapor which re-forms from intergaseous reactions; more water seeps in and comes in on the work. But in Lithium Furnaces here is the vital difference—the metallic vapor in the Lithium Process immediately removes every trace of water vapor . . . keeps the atmosphere chemically inert, dry as a bone and unable to react with the steel. That is why steel treated by the Lithium Process comes out truly bright, without the slightest trace of scale or decarburization.

The same principles apply with equal importance to gas carburizing. Elimination of scale and decarb reactions results in fast, bright carburizing both in and below the eutectoid range.

Obviously, the simple Lithium Process makes possible many savings in investment and operating costs, and an unequalled quality of work which will be highly desirable in the coming competitive era.

*Send for this NEW 20-page BOOK. It answers all your questions about Lithium: what it does and how it does it, what it saves.

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NEUTRAL HEATING OF ALL STEELS
DESCALING AND CLEANING
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BRIGHT EUTECTOID CARBURIZING

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Strength in Tension and Compression
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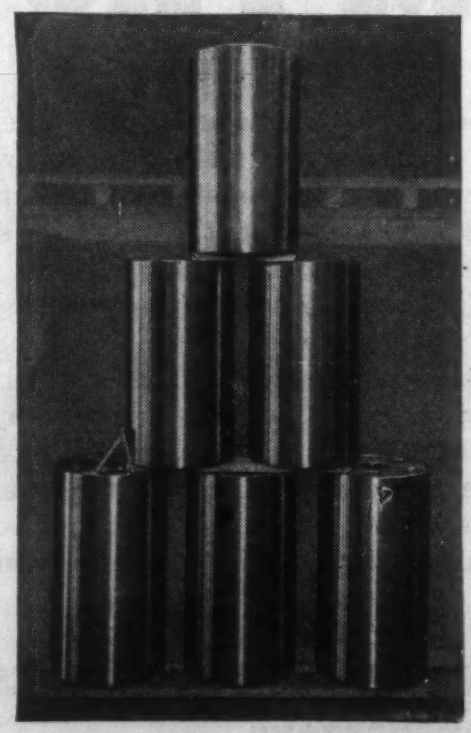
No doubt, but that one of "our own" alloys, or one of the numerous non-ferrous alloys we can readily make, will meet your requirements— Why not tell us your post war problems along these lines, and let our Engineers give you the benefit of their knowledge and experience— No obligation.



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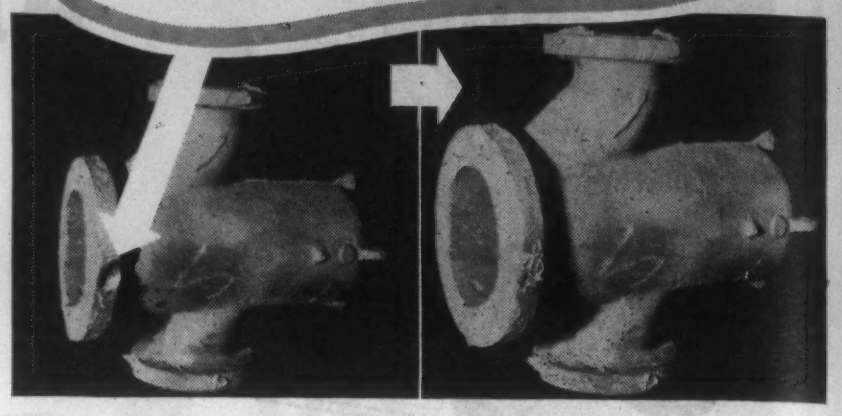
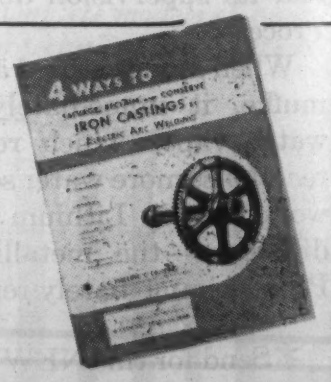


5 minutes welding with PHILLIPS "600" Electrode saved this 180-lb. iron casting

IT is the work of a very few minutes, and it takes only a few cents' worth of material, to restore this gray iron casting completely. After machining the weld cannot be distinguished from the parent metal, because PHILLIPS "600" deposits are the same color as cast iron. And there is no difficulty about machining, drilling, tapping, etc., because the deposit is fully machinable, including the line of fusion.

Consult with Phillips on all cast iron salvage, maintenance and repair problems. There is a correct rod for every application of electric arc welding to cast iron, and Phillips has it. There is also a correct procedure for each of these applications—and Phillips can supply it.

This new manual is a complete guide to the selection of materials and procedures for arc welding cast iron. Send for your copy TODAY.



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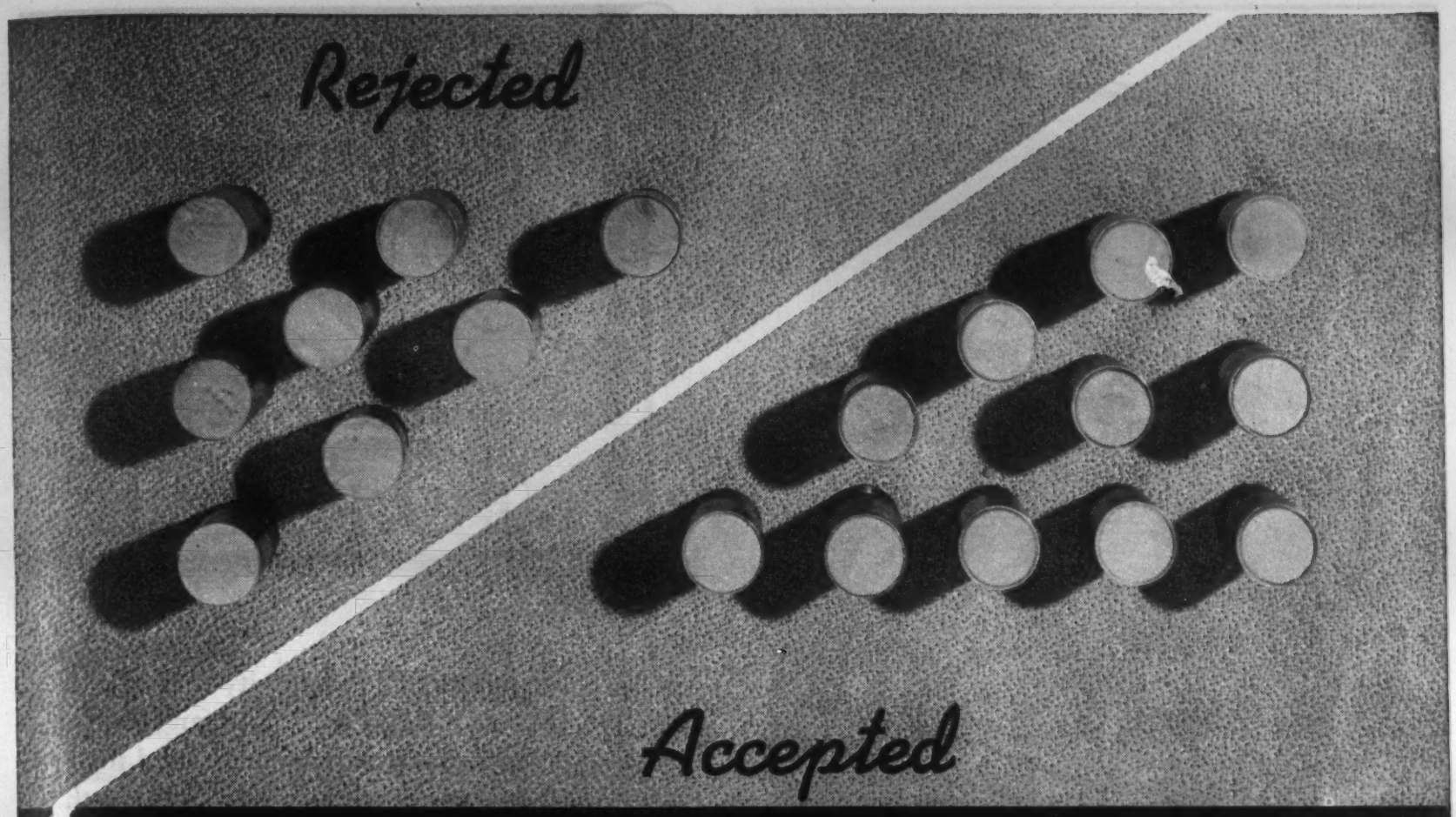

A PRACTICAL COMPARISON OF CASE DEPTH IN PRODUCTION, WITH THE DuMONT Cyclograph

ARMY E NAVY

These parts have a specified lower limit case depth of .025".

The DuMont Cyclograph sorts these parts into two groups: Group A, case depth less than .025"; Group B, case depth more than .025". This non-destructive, positive, 100% quality inspection has handled several hundred thousand such pieces to date, at a rate of 15,000 per day.

If you are vitally interested in checking case depth on production runs, the Cyclograph may provide that 100% inspection means on a wide variety of shapes and sizes of pieces.

Also, the Cyclograph grades and sorts according to analysis, structure, decarburization, plating or cladding thickness, internal stresses, etc., on ferrous and non-ferrous metals.

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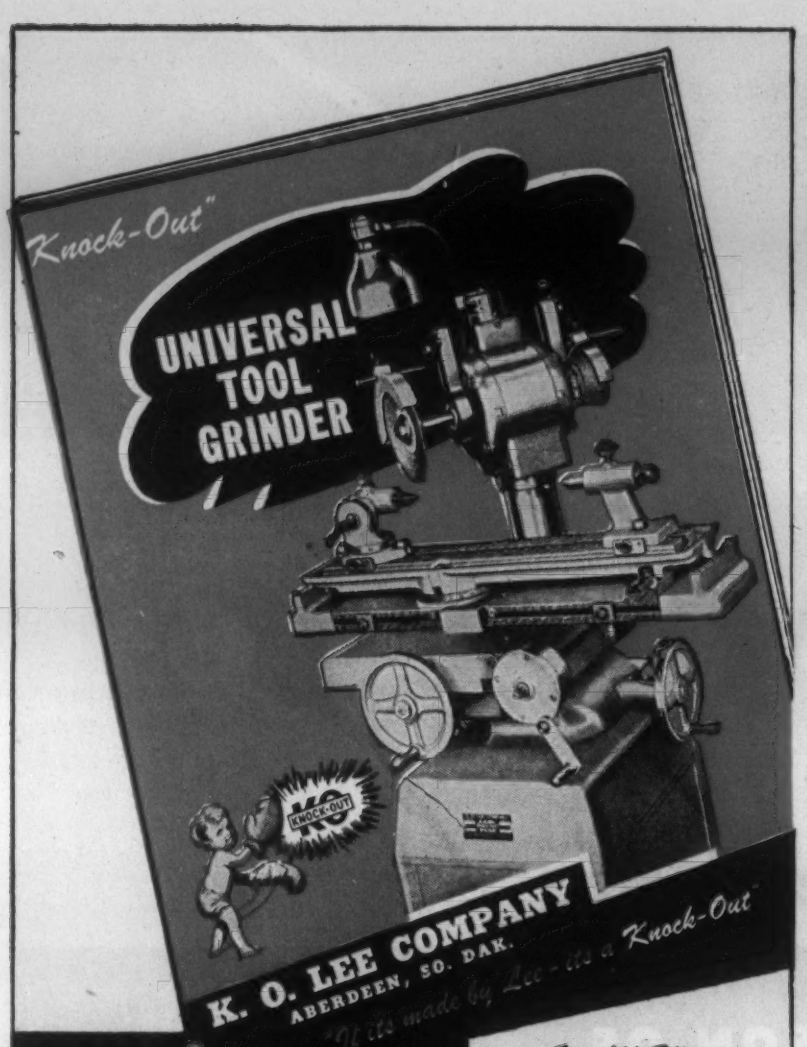

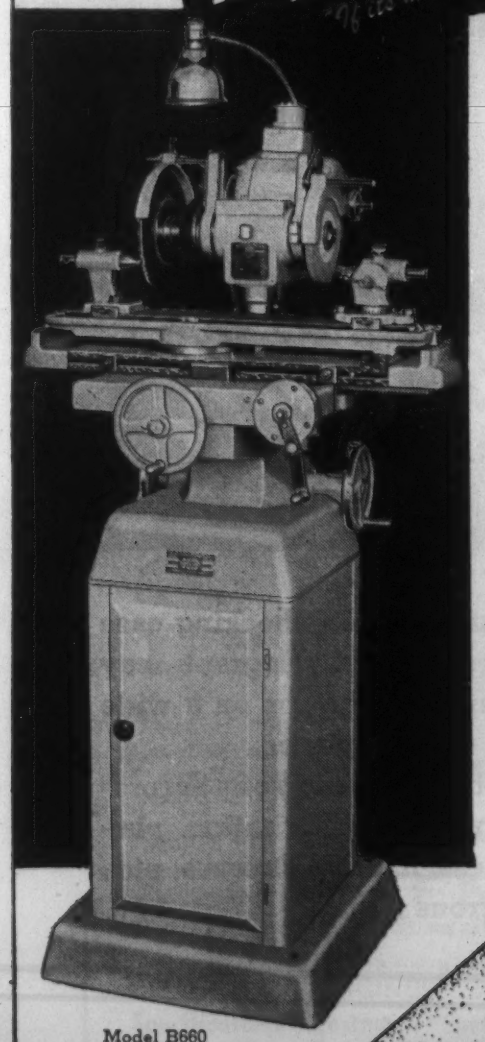

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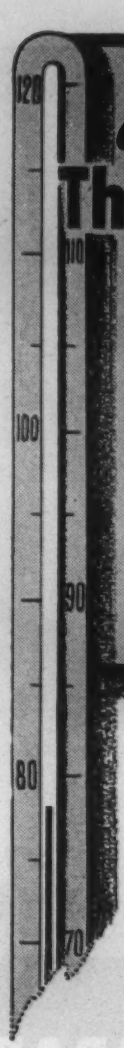

an ALLOY *with a* Thermal Conductivity *Only* 2% *that of* COPPER

Thermal conductivity of Chace Manganese Alloy No. 772 is far below the values of alloys ordinarily used for low heat transfer applications. It is less than 50% that of steel . . . less than 10% that of brass . . . and only 2% that of copper.

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Barriers of this alloy have been used to reduce heat losses by 50%. Where heat losses tend to upset action— or where handles or other parts of devices must be kept cool—try Chace Alloy No. 772.

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This alloy has also high electrical resistivity, 1050 ohms per circular mil foot . . . a temperature coefficient of expansion twice as great as that of ordinary steel . . . a vibration damping constant about 25 times greater than steel. It is available in sheets from .003″ up in thickness, and from .0625″ to 6″ wide . . . in rods down to .125″ diameter . . . in wire down to 16 gauge .050″ . . . and also in special shapes.

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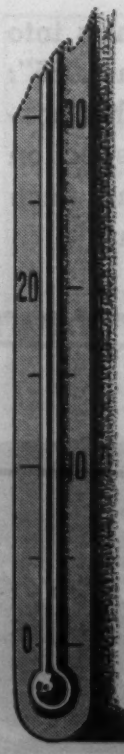

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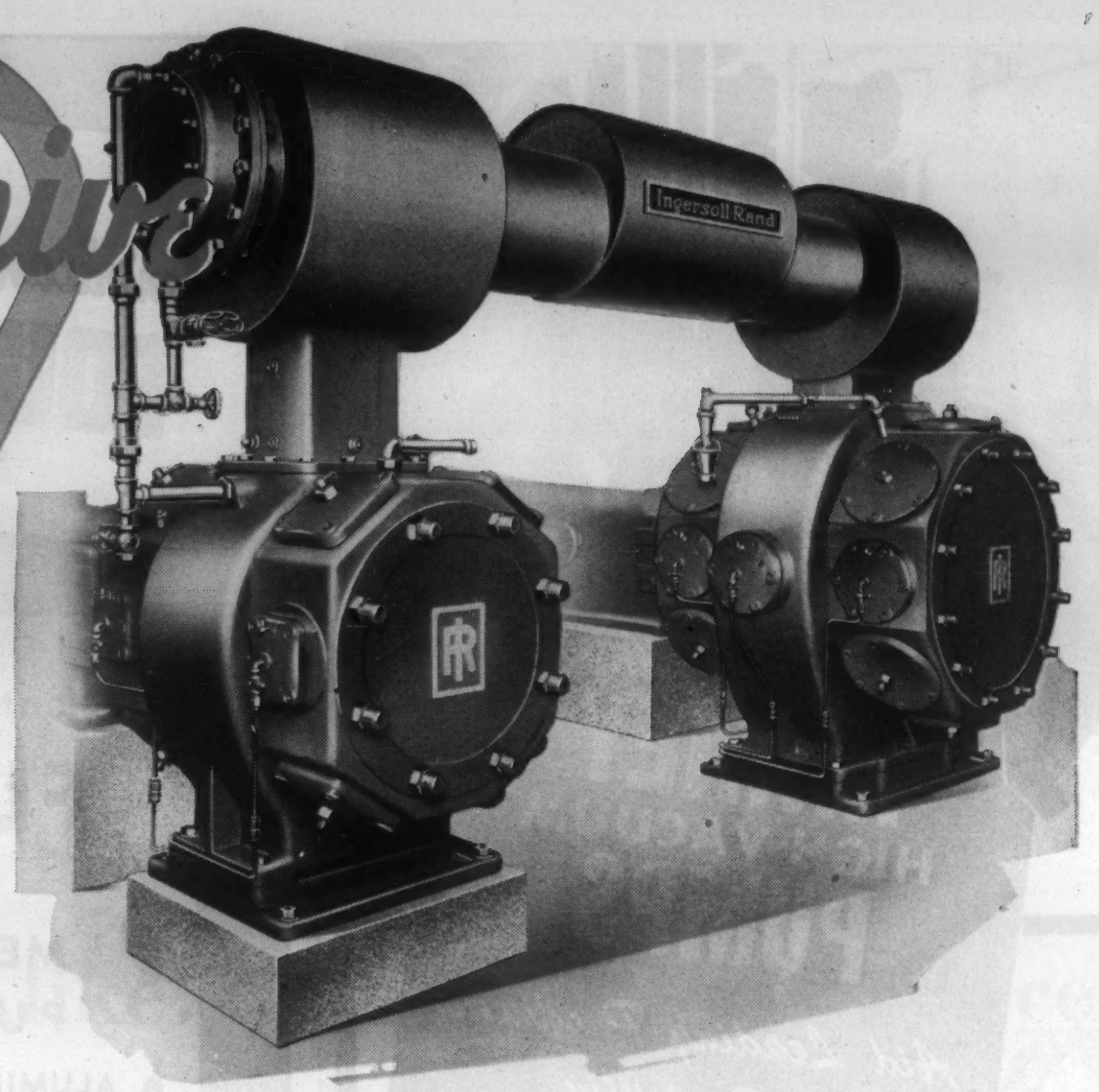

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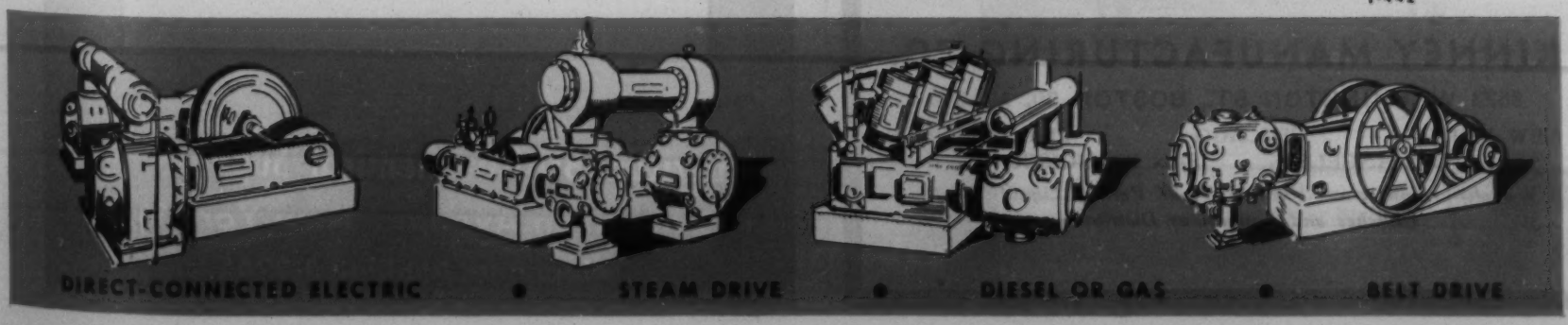

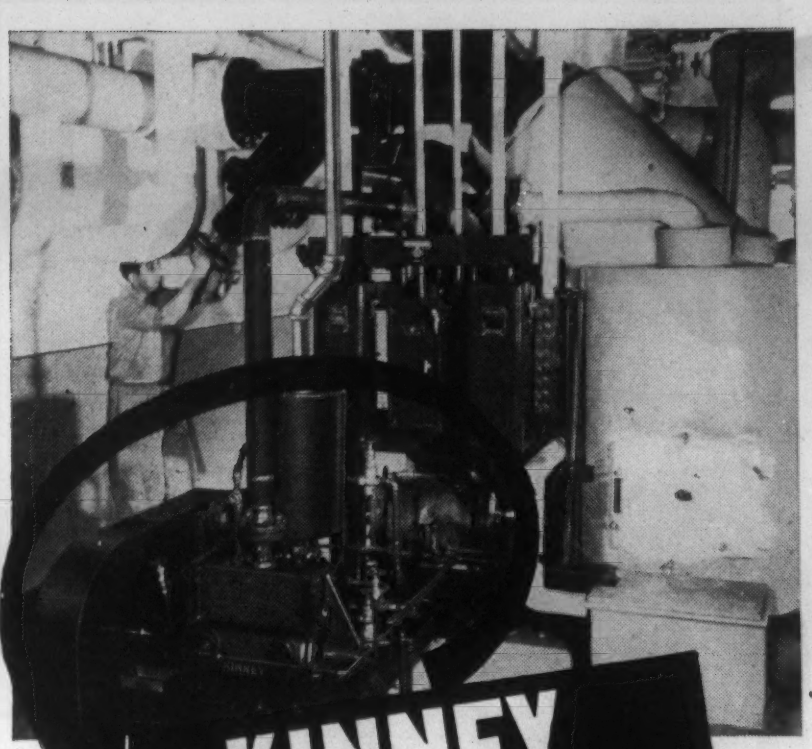

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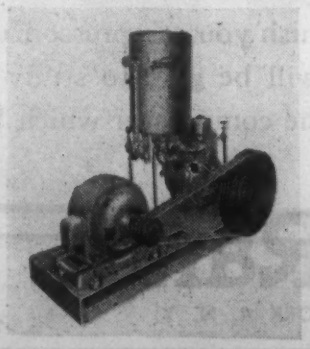

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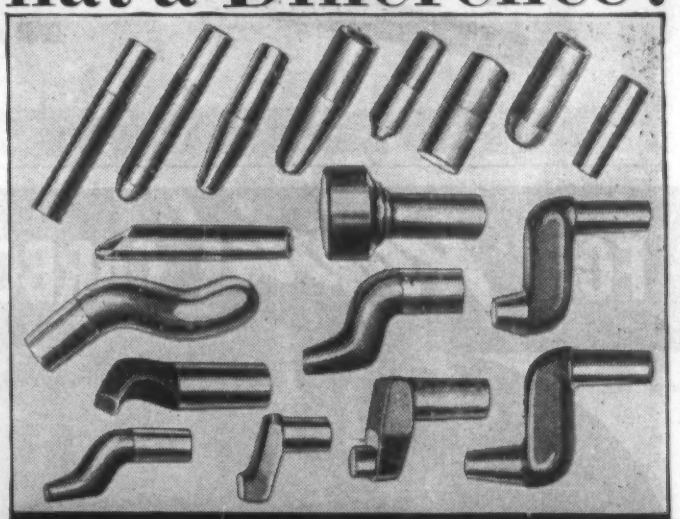

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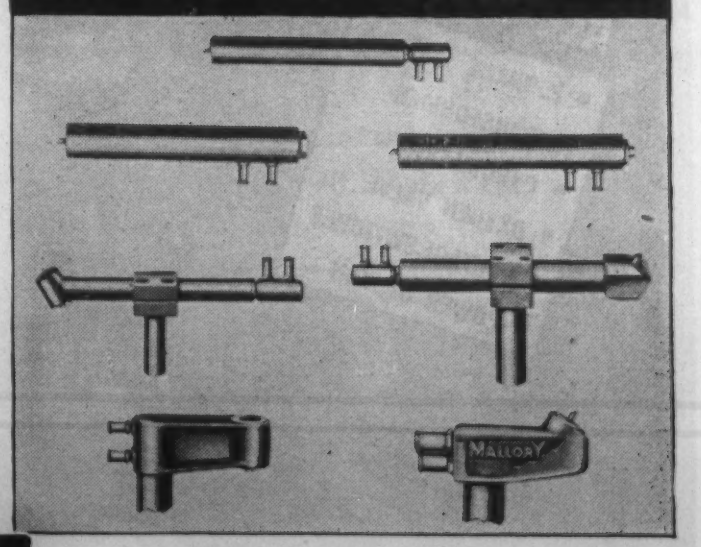

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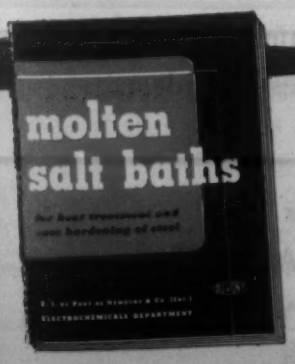

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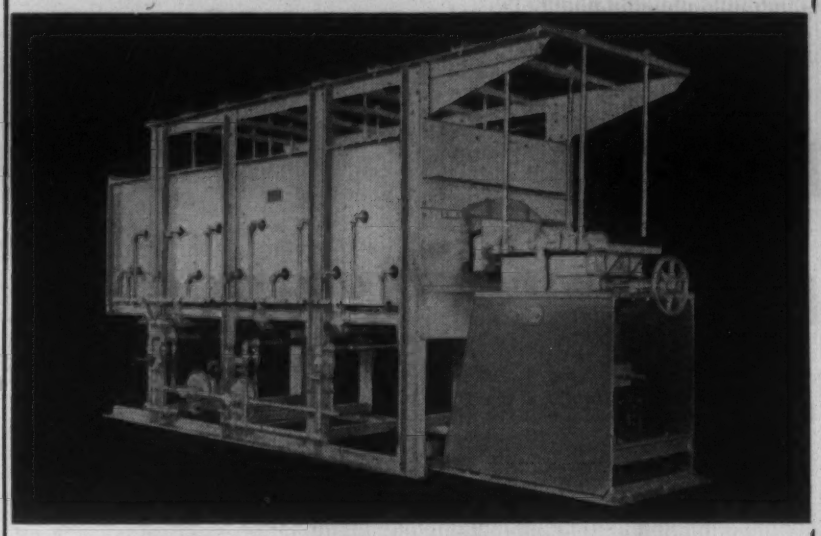

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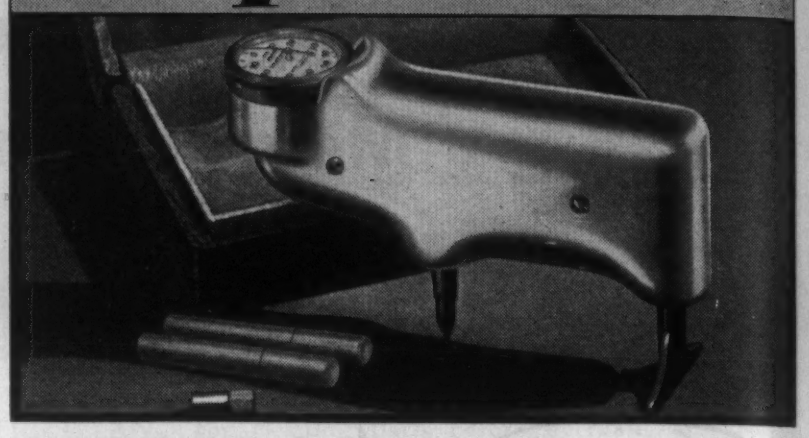

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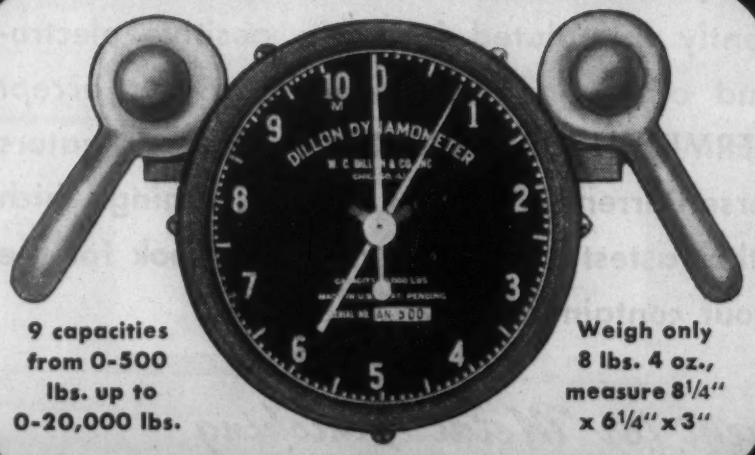

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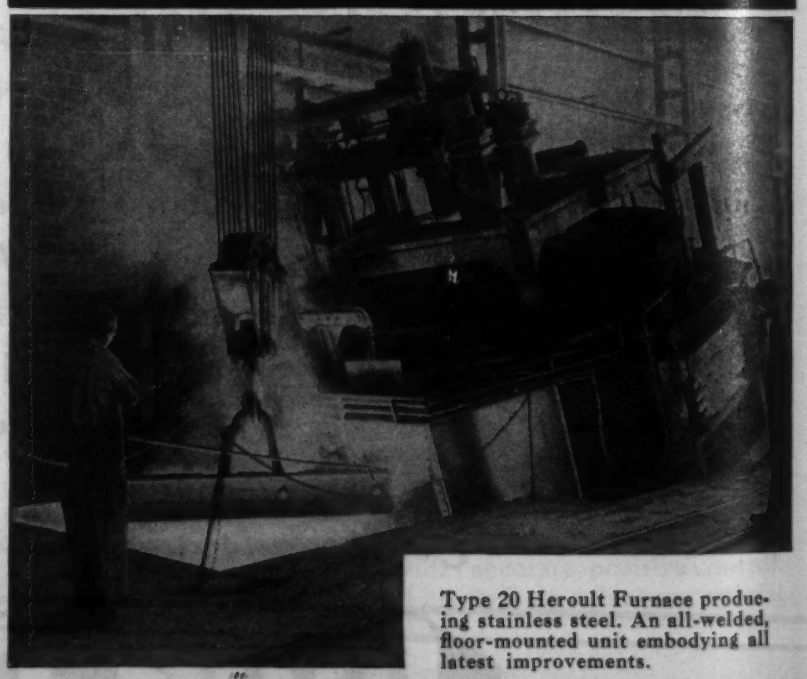

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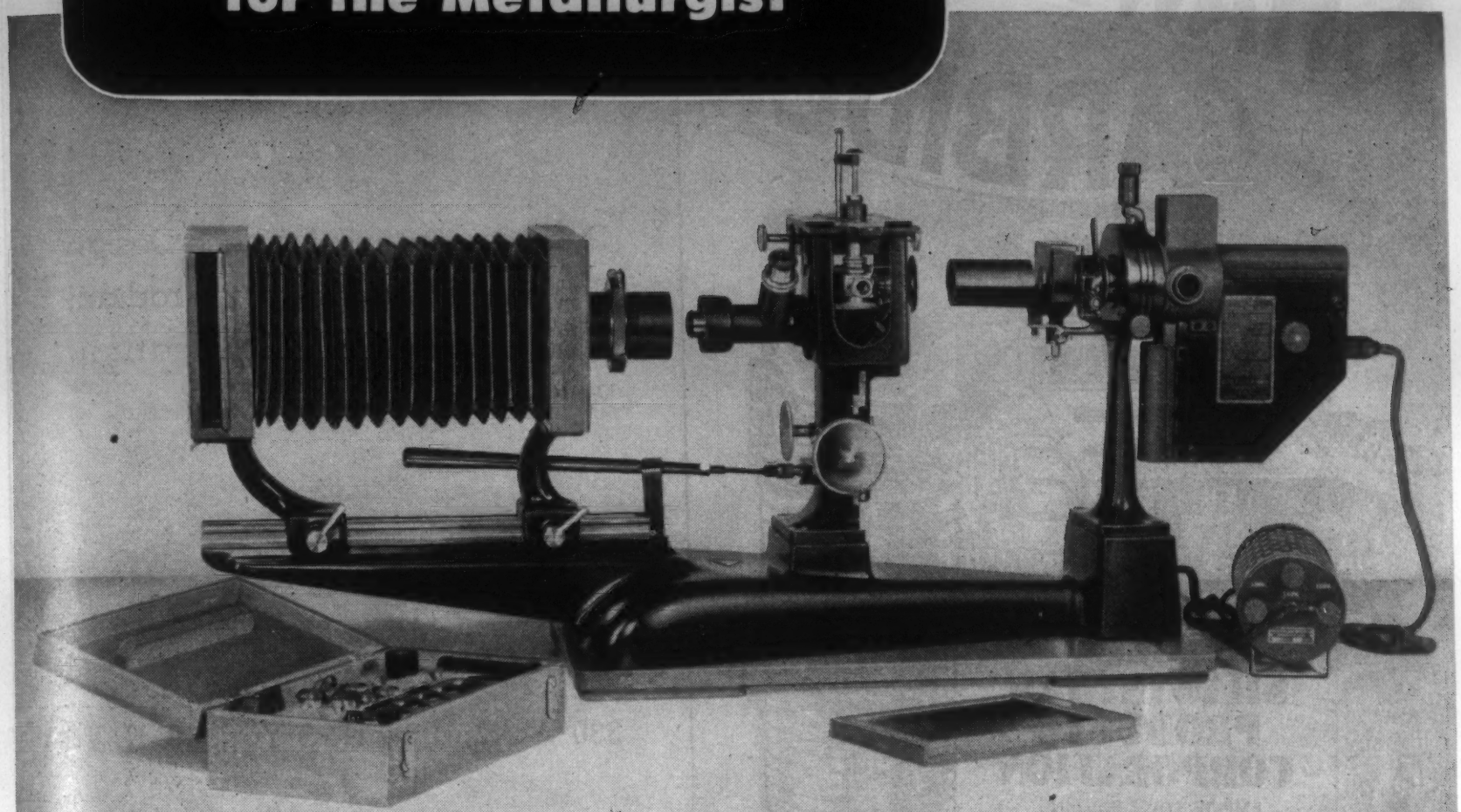

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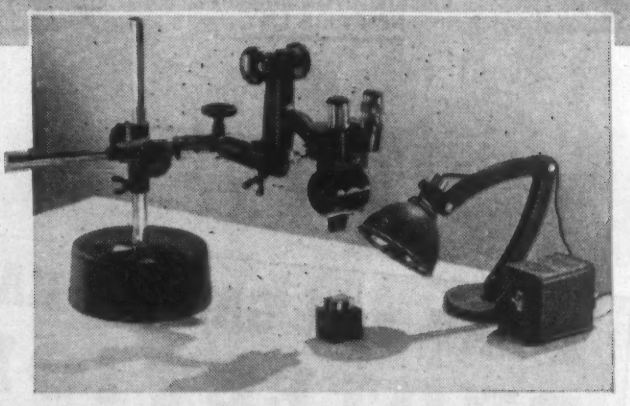

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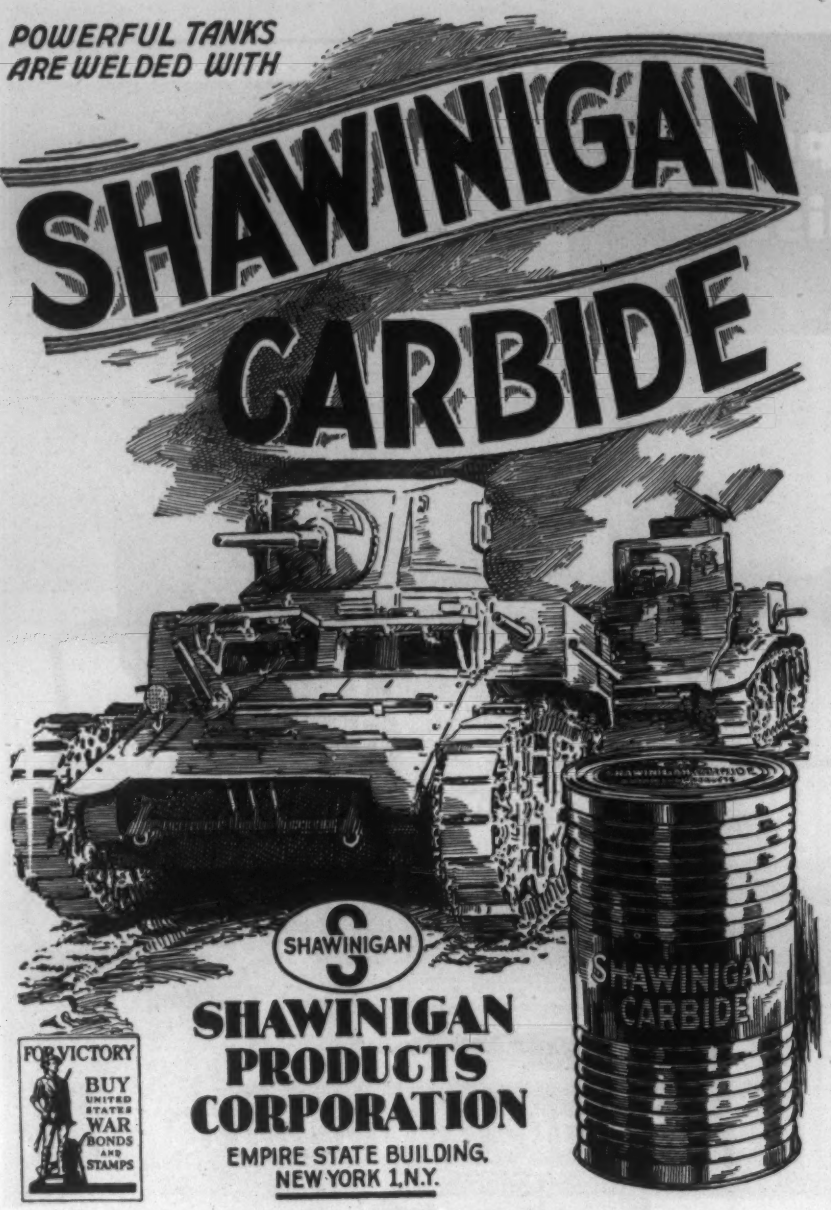

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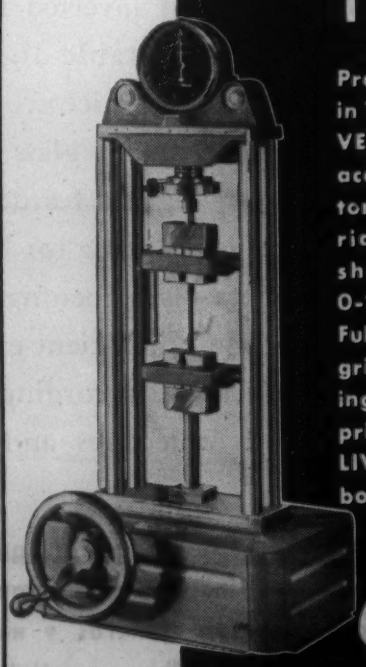

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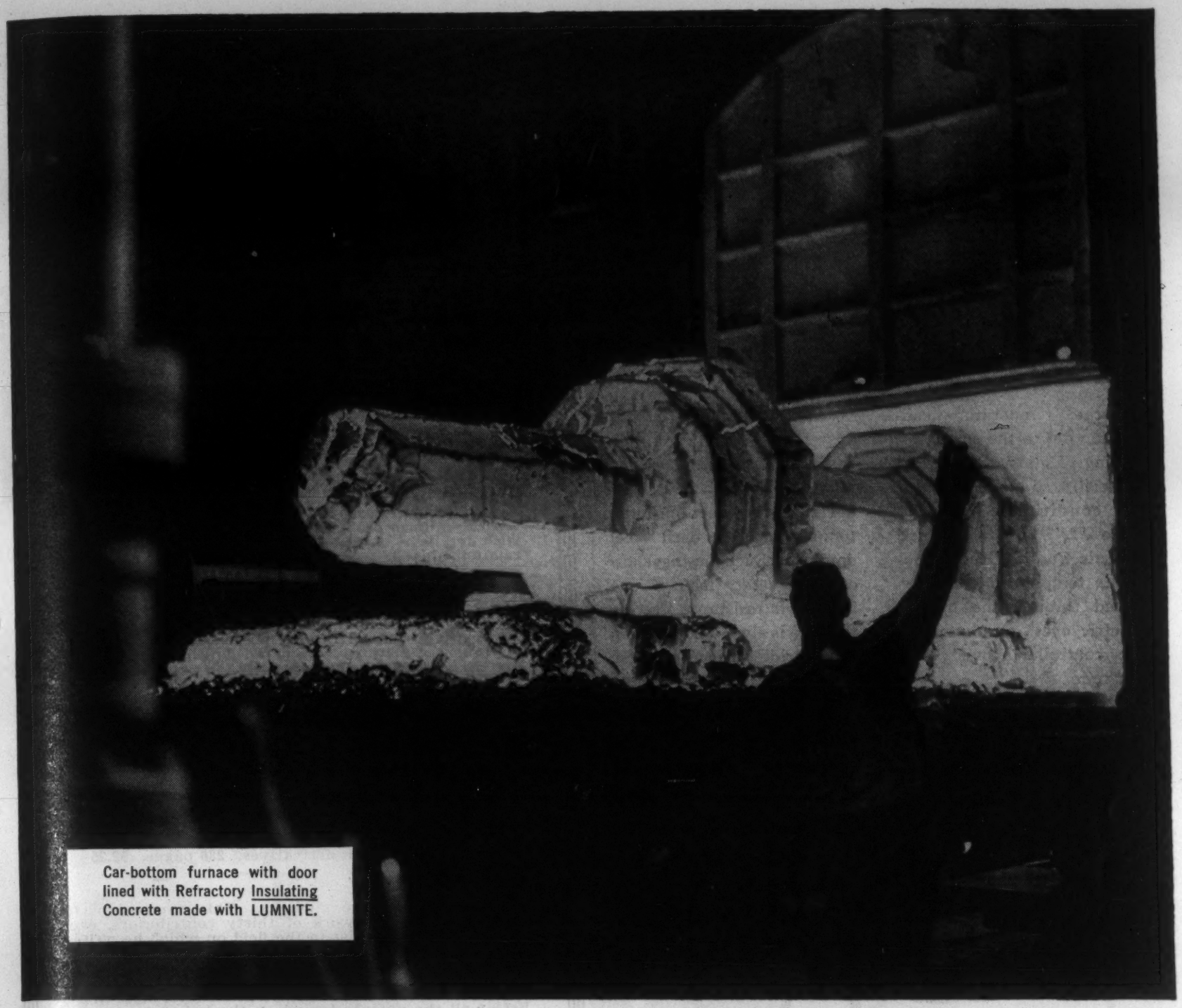

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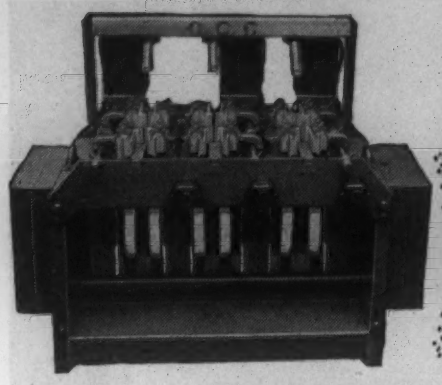

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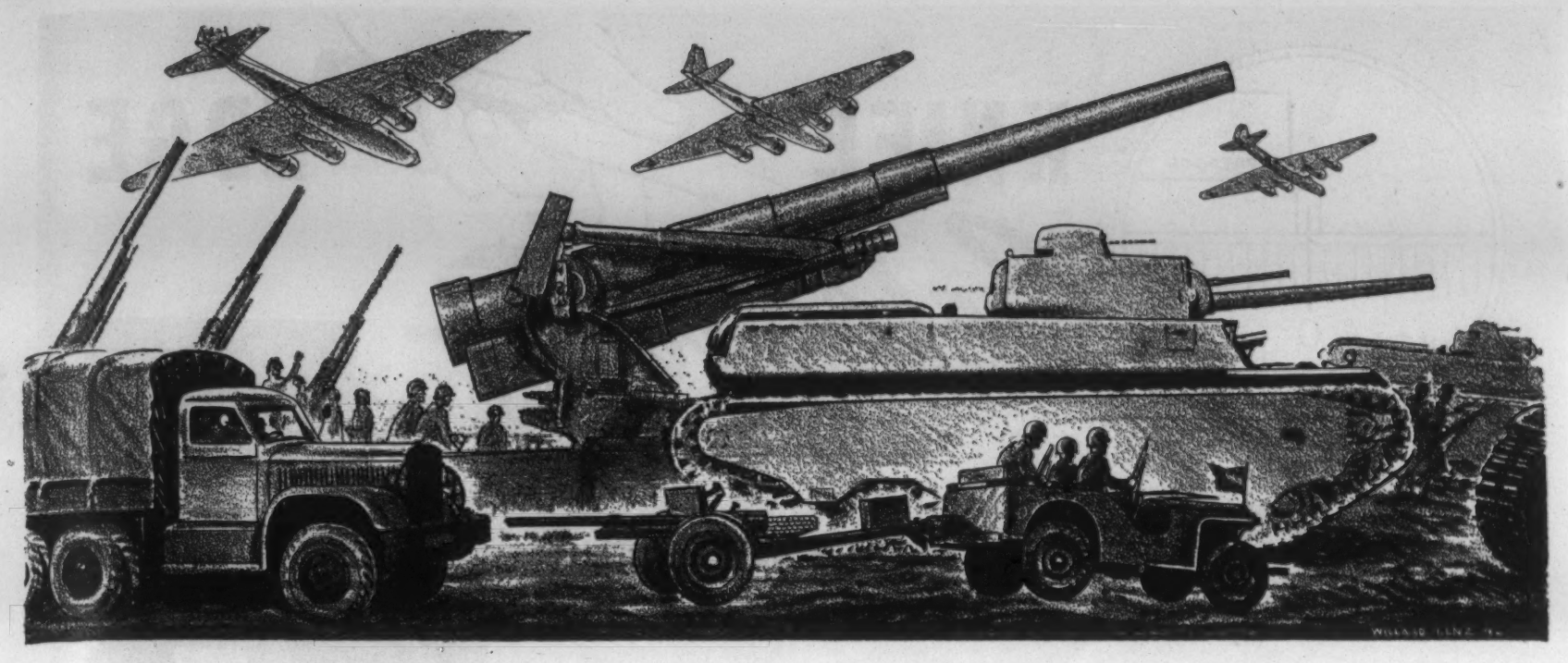

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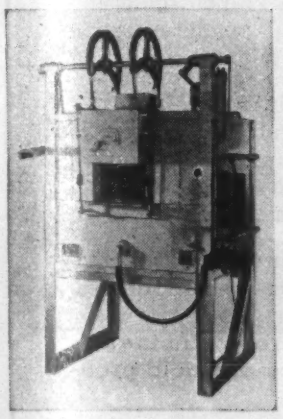

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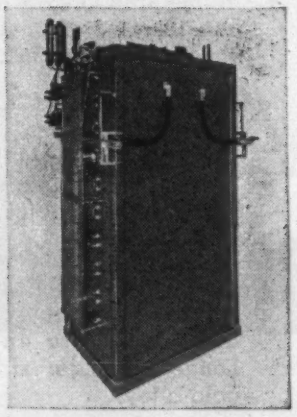

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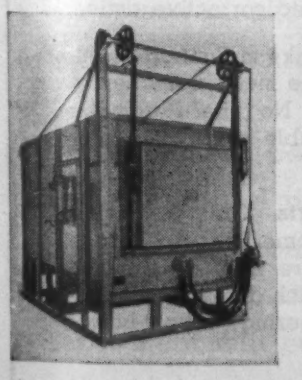

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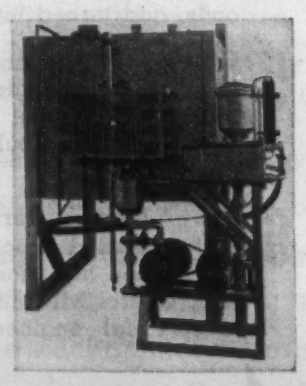

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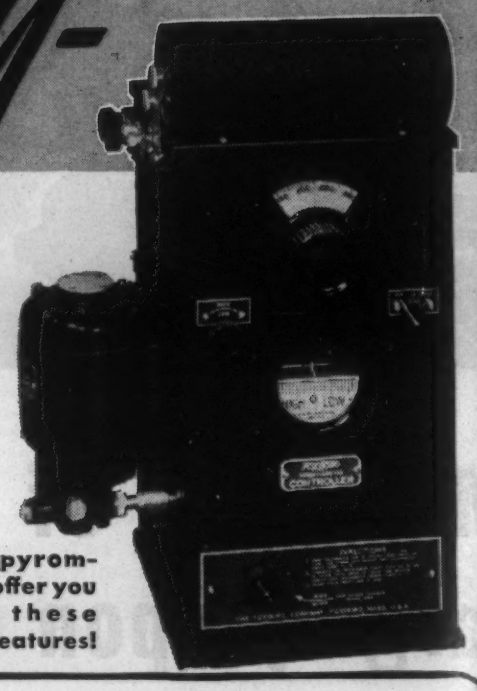

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Univex Die Cast & Engineering Co. 1751
Upton Electric Furnace Div. 1569
Agency—Alfred B. Hard Co.

Van Norman Co. 1520
Agency—Sutherland-Abbott
Victor Equipment Co. 1536
Agency—George Lynn

Watson-Stillman Co. 1549
Agency—O. S. Tyson & Co., Inc.
Weirton Steel Co. 1683
Agency—Ketchum, Macleod & Grove, Inc.
Western Cartridge Co. 1749
Agency—D'Arcy Advertising Co.
Westinghouse Elec. & Mfg. Co. 1530, 1531, 1534, 1535, 1538, Inside Back Cover
Agency—Fuller & Smith & Ross, Inc.
Wickwire Spencer Steel Co. 1539
Agency—Fuller & Smith & Ross, Inc.
Wilson, H. A., Co. 1540
Agency—Charles Dallas Reach Co.
Wilson Mechanical Instrument Co. .. 1708
Wolff, Conrad 1778
Wrigley, Wm., Jr., Co. 1780
Agency—Ruthrauff & Ryan, Inc.

Youngstown Sheet and Tube Co. 1557
Agency—Griswold-Eshleman Co.

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MEMBER AUDIT BUREAU OF CIRCULATIONS

trends

By Edwin F. Cone

Electric vs. Open-Hearth Steel

There has been a gradual decline during the war in the percentage of alloy steels made in basic open-hearth furnaces of the total alloy steel output. In 1934 alloy steels from basic open-hearth furnaces constituted 80% of the total alloy steel ingots and steel for castings, according to statistics of the A.I.S.I. In 1939 this proportion had declined to 71.7%, but in 1942 and 1943 it was 65.4% and 65.1%, respectively. This means, of course, an increase in the relative output from electric furnaces.

Aluminum Permanent Mold Castings

In the Springfield, Mass., foundry which the Reynolds Metals Co. has leased from the D.F.C. the production of aluminum permanent mold castings was scheduled to start in mid-September. The company's plans call for post-war operation of this plant as an integrated part of the Reynolds aluminum producing organization. Post-war plans call for the production not only of permanent mold castings but also pressure die and sand castings for automobile motors, washing machines and vacuum cleaners, along with a complete line of cast aluminum cooking utensils.

Near Peak in Steel and Pig Iron Capacity

The gradually increased steel and pig iron making capacity of the country had almost reached its peak July 1. The "virtual conclusion of the tremendous emergency expansion program" is reported by the American Iron and Steel Institute as 94,054,550 net tons of ingots and steel for castings per year and 68,446,310 tons of pig iron and ferroalloys. Since January, 1940, there has been a net increase of over 12,700,000 tons in annual blast furnace capacity and of more than 12,400,000 tons in steel making capacity. The program "ranks among the greatest industrial construction undertaking of all time."

Steel Consumption for Ships

Shipments of steel to shipbuilders continue to top the list. As during the entire year of 1943, so for the first 6 months of this year, practically one-fifth of the nation's total steel shipments were sent to builders of ships, says the American Iron and Steel Institute. By far the nation's largest wartime consumer of steel, merchant and naval ship construction required 19.5% of the total steel shipped in the first half of 1944. Last year the percentage was 19.2% while in 1942 it was 15.6%.

Studies in Corrosion

A corrosion problem which has cost the petroleum industry hundreds of thousands of dollars will be studied by the Battelle Memorial Institute under a research program recently initiated for the Natural Gasoline Assoc. of America. The problem is the serious corrosion of pipes and fittings of high pressure condensate wells, most of which range in depth from 7000 to 10,000 or more feet. The extensive study of this corrosion problem of "unusual hazard" is another step in the progressive research program of the country as a whole.

A. F. A. Membership

As of June 30, 1944, the membership of the American Foundrymen's Association was 6620, an all-time high. On June 30, 1943, the figure was 5665 with 5047 on June 30, 1942. There are now 27 local chapters in the society.

Steel Castings Output

Production of commercial steel castings, as reported by the Bureau of Census, Dept. of Commerce, continues to expand. The production for the first 6 mo. of 1944 has been 970,785 net tons or 161,797 tons per mo. This compares with 160,720 tons and 139,931 tons per mo. for all of 1943 and 1942 respectively. The June output was 157,444 tons with 174,626 tons in March, the largest for the first half.

Cold-Finished Sheets and Bars

The discoverer of the method of cold rolling sheets and bars died in 1894 (50 yr. ago) at the age of 74. He was Bernard Lauch. These products are now very important in the steel industry. The discovery, says the American Iron and Steel Institute, was made at Pittsburgh in 1859. The inventor realized that the new process, in addition to producing accurate size and bright, smooth surface, also imparted rigidity to steel bars. The production has been decidedly on the increase and over 2,000,000 tons of bars were cold finished by the steel industry in 1943.

Bessemer Steel Output

Since 1939 there has been a gradual increase in the country's output of Bessemer steel, often the "forgotten steel." In 1943 the total was 5,625,492 net tons, a substantial increase over the 5,553,474, in 1942, both respectively a record. In 1939 only 3,358,916 tons were made. This is a gain of nearly 66% in 4 yr.

JAN 1 1945

METALS and ALLOYS

The Engineering Magazine of the Metal-Working Industries

DECEMBER 1944

Metal Production · Metal Working · Materials and Design

How to Evaluate Insulating Firebrick

1. Temperature Resistance
2. Light Weight for Low Conductivity
3. Stability
4. Volume Change
5. Manufacturer's Responsibility
6. Value

3

A Reliable Measure of Stability

The stability of an insulating firebrick is the key to its service life, its true cost, on a service-time basis. High stability, long life, low yearly cost. Load-strength data are readily available, but should be used with caution. Some are given as cold crushing-strengths. Some are stated as hot load-strengths. They are not comparable. Hot load-strength is more reliable. It is more related to service conditions, when the brick are under fire.

Your local B&W representative will gladly supply particulars on this and the five other simple checks you can make in selecting an insulating firebrick of greatest value to you.

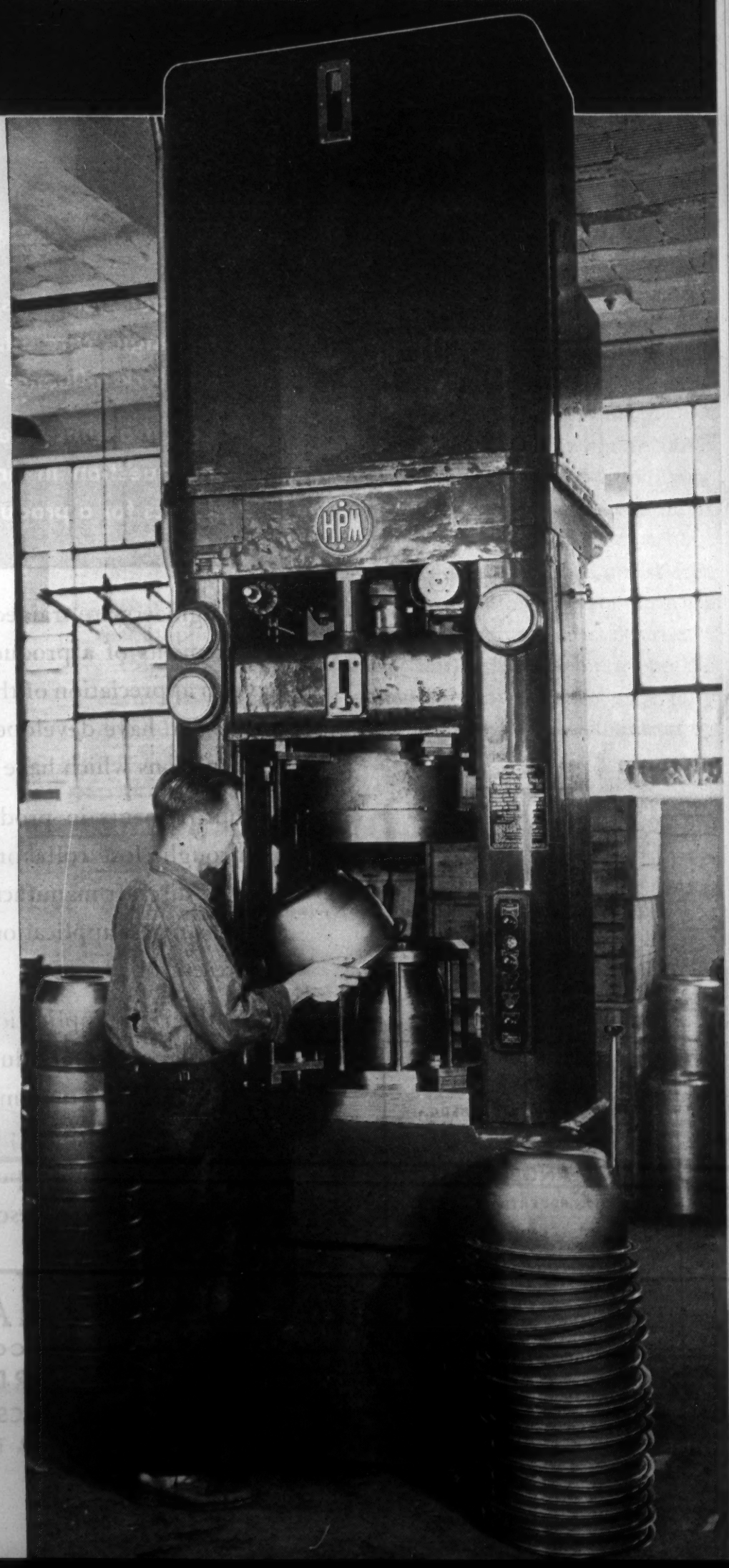
THE BABCOCK & WILCOX COMPANY
Refractories Division
85 LIBERTY ST. NEW YORK 6, N. Y.

ARMY E NAVY

BABCOCK & WILCOX

BUY WAR BONDS! BUY MORE THAN BEFORE

REGARDLESS OF THE SIZE OF YOUR SHEET METAL PARTS...*Draw them hydraulically* WITH H·P·M FASTRAVERSE PRESSES



SPEED, flexibility and versatility make the self-contained H-P-M FASTRAVERSE press the ideal production tool for sheet metal drawing. Small, light gauge parts can be drawn just as efficiently as large, heavy parts. The advantages obtained in applying modern hydraulics to metal forming operations are the same, regardless of the size of H-P-M press employed.

The total elimination of wrinkling and tearing saves both stock and production time. There is no distortion or "spring back" after the part is released from the die.

Deeper draws (far greater than can be made with crank or cam driven presses), less rejects, fewer operations, faster production and less maintenance are the natural results of applying modern H-P-M hydraulics to sheet metal forming work. Investigate the possibilities of lowering your metal working costs with H-P-M FASTRAVERSE presses. Write today, stating your requirements.

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THE HYDRAULIC PRESS MFG. CO.

Mount Gilead, Ohio, U. S. A.

Branch Offices: New York, Philadelphia, Cleveland, Detroit and Chicago. Representatives in principal cities.

"CAN IT BE IMPROVED...WITH PLASTICS?"

This question does not presuppose that plastics is the magic "cure-all." On the contrary it rules out the lady-luck influence as irrelevant to the problem.

"Can it be improved with Plastics?" is the number one question in any consideration of engineered plastics for a product or part.

Our engineers are trained to consider plastics in relation to the requirements of a product and the improvement desired. They have an appreciation of the complementary values of plastics and metals and have developed some original techniques with these combinations which have solved a number of product problems.

Improvements in products and parts have been attained by us through close collaboration with the design and production staffs of aircraft manufacturers. Along similar lines, we may be able to suggest applications of molded plastics to your products . . . present or planned.

For the right application of plastics to your product, call on Plastic Manufacturers during the design stage. The design of your product may determine how close tolerances can be held. Selection of the right plastic material and molding method should be left to our experienced judgment. Send for free copy of Folder File MA12, describing our facilities.

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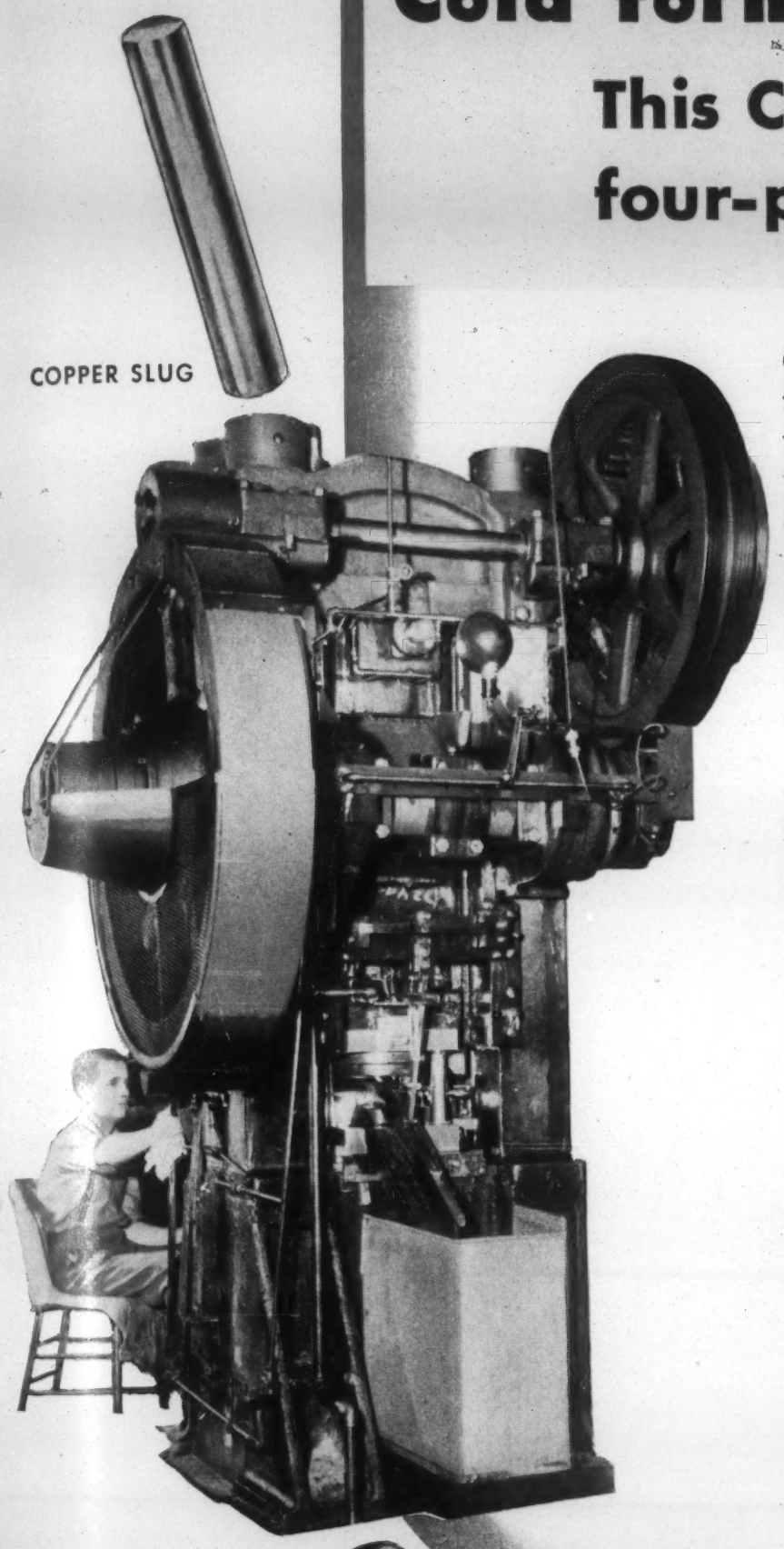
PLASTIC MANUFACTURERS

INCORPORATED
STAMFORD, CONNECTICUT
ENGINEERED PLASTICS FOR INDUSTRIAL APPLICATIONS
MOLD MAKING • INJECTION & TRANSFER MOLDING • COMPLETE ASSEMBLY

Cold formed in one stroke

This Copper cap replaces four-piece Gillette assembly



Caps for Gillette Razors were formerly made in four pieces; the curved plate with a centered hole, a threaded center pin to which the handle was attached, and two studs for holding the blade in position. Furthermore, assembling the cap was a slow and tedious operation.

But things are different now—a faster, more accurate and economical method has been devised. Because of the excellent cold working properties of copper, thousands of caps are now produced daily . . . formed in one piece . . . in 400-ton presses.

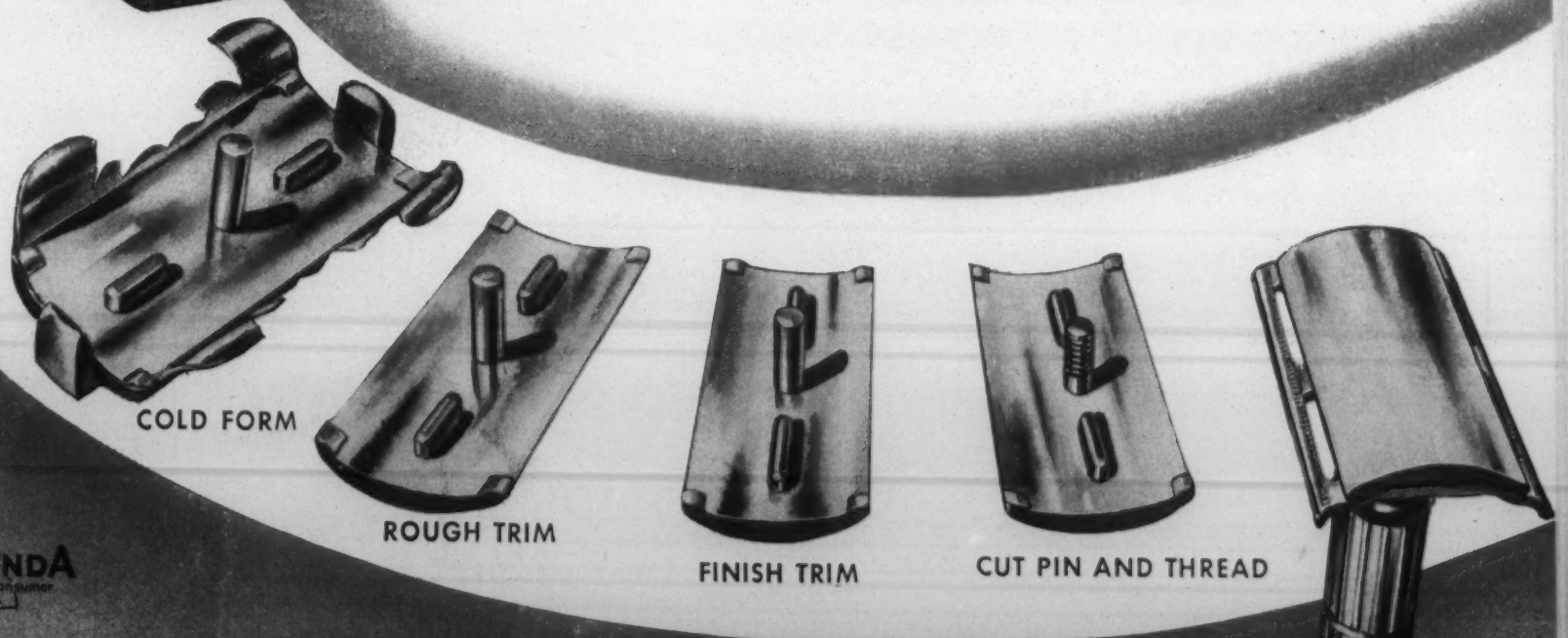
Coils of Anaconda Copper Rod .320″ diameter, are cut into slugs 1¾″ long and are magazine-fed into the press. The cold formed part, with flash attached, is illustrated below in actual size. The sequence of finishing operations is also shown.

RESULTS: *1.* Production has been speeded up about 200%. *2.* The one-piece construction eliminates the possibility of assembled parts working loose. *3.* Extremely accurate dimensions, necessary for blade alignment, are maintained without difficulty. And, as nothing serves like copper as a rust-free base metal for applied finishes, these Gillette Razor parts are readily plated with gold, nickel, chromium—or as desired.

Copper, or one of its many workable alloys, may be the answer to a similar job which you may consider especially difficult. Your inquiry will be given every consideration by our Technical Department.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*



ANACONDA
from mine to consumer

Anaconda Copper & Copper Alloys

It takes more than Modern Equipment to meet ALL Sheet Metal Requirements

Production men know that low costs and smooth-flowing manufacturing operations go hand in hand when materials are consistently uniform—when sheet after sheet or coil after coil have the same fabricating characteristics.

But there's more to the making of such metal than modern equipment—important as that is. To produce brass plate, sheet or strip that meets ALL requirements calls for strict technical control over every step of production, from the casting shop to the last pass on the finishing rolls. For only in this way can the composition, grain size, temper and finish be controlled to obtain the best combination of properties for spinning, stamping, deep drawing or other fabricating operations.

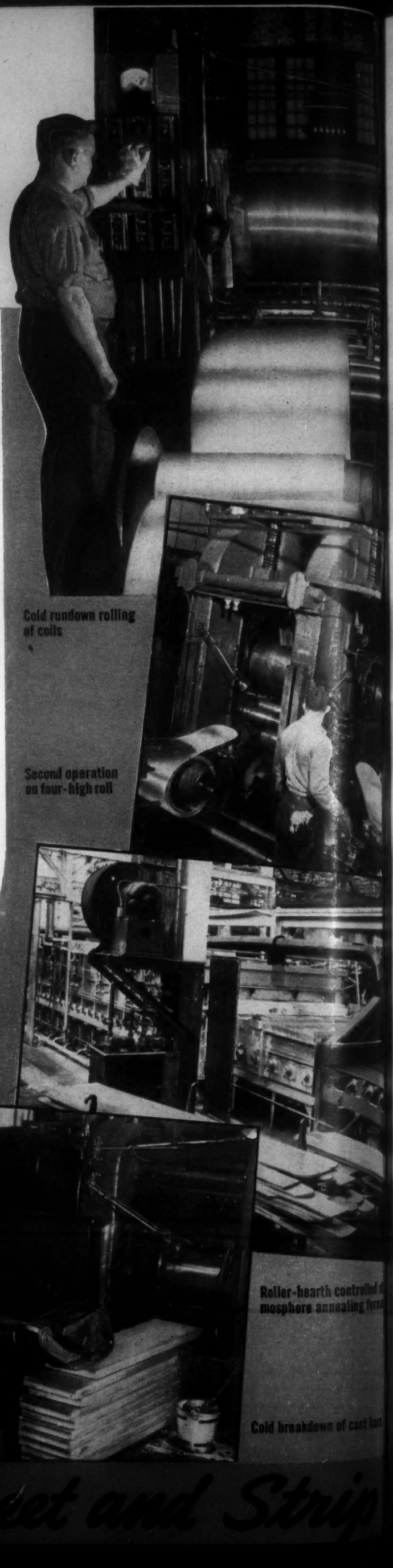
In all probability, much time was devoted to the design and development of your sheet metal products—and also considerable money in tooling up for their production. So when you order copper, brass, bronze, or nickel silver, take the added precaution of specifying "ANACONDA". This is your assurance that the product is made by THE AMERICAN BRASS COMPANY to consistently uniform specifications and tolerances.

44210

THE AMERICAN BRASS COMPANY

ANACONDA
from mine to consumer

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*



Cold rundown rolling of coils

Second operation on four-high roll

Casting bars in water-cooled mold

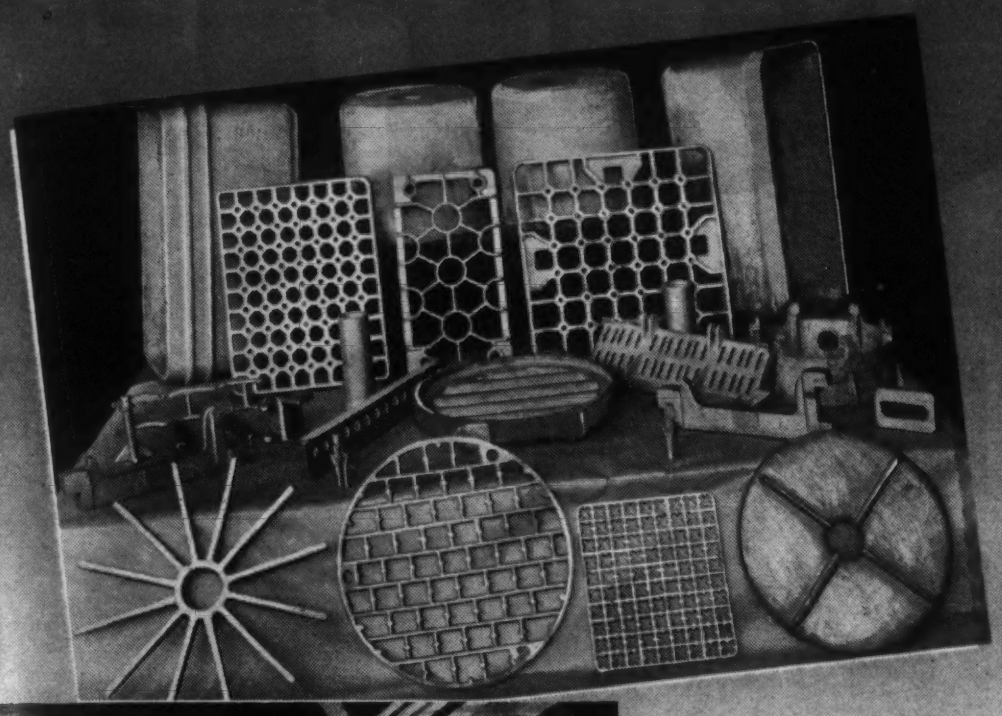
Roller-hearth controlled mosphere annealing furna

Cold breakdown of cast bars

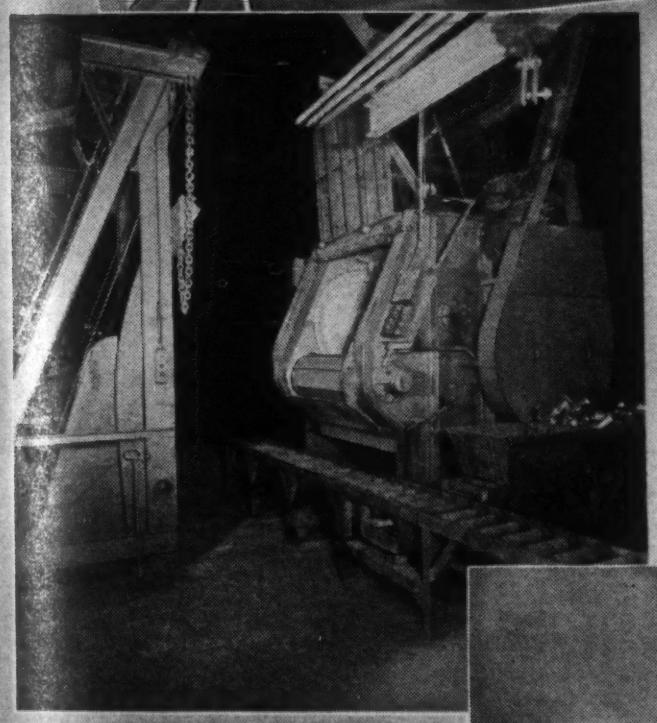
Anaconda Plate, Sheet and Strip

There's No Substitute For Alloy Experience —

"SWESCO" ALLOY CASTINGS

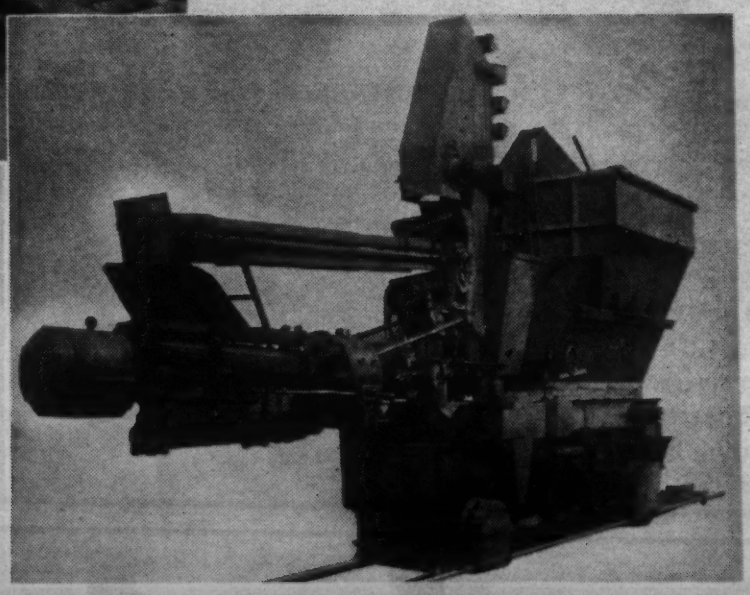


. . . In Greater Demand Than Ever Before . . . For 32 Years "Know-How" Go Into Their Making!



As early as 1912, the Swedish Crucible Steel Company was prominent in the development of nickel-chrome heat resistant castings, designed to resist oxidation, corrosion, and abrasion. Today this early experience is treasured, for the knowledge and skill so gained has proved invaluable in producing "SWESCO" Alloy Castings of superior quality. Evidence of this is their ever-increasing demand by manufacturers who recognize "SWESCO" superiority.

MODERN FACILITIES, SKILL AND CARE . . . MEAN SAVINGS ON YOUR ALLOY CASTINGS REQUIREMENTS.



The Sand Slinger and Wheelabrator illustrated are but two of the modern foundry essentials that make Swedish one of the best equipped foundries in the country for the production of Alloy Castings. Our skill, care, modern equipment and, above all, experience can be of real service to you on your Alloy Castings requirements, and we welcome the opportunity to assist you in any way possible. For detailed information please write, wire or telephone Dept. SCS-54.

Pioneers in the development of Alloy Castings to meet today's Industrial demands

Swedish CRUCIBLE STEEL COMPANY

Serving Industry For More Than Thirty-Two Years

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Micarta

MICARTA
meets problems like these and hundreds more

MILLIONS OF MICARTA HELMETS have been produced for the protection of our Armed Forces. This wartime application demonstrates the deep-draw possibilities of this industrial plastic, as well as its great impact strength.

SMOOTH BEARINGS FOR ROUGH CROSSINGS. Destroyers, destroyer escort vessels, LCI ships and many other U. S. Navy and Maritime vessels depend on Micarta stern tube bearings. Micarta cushions shocks of heavy seas, multiplies bearing life as much as 400 per cent, is unharmed by constant immersion in salt water.

CONTROL PULLEYS FOR PLANES have been made of Micarta for over a quarter of a century. They extend the life of both pulley and cable.

WESTINGHOUSE

the No. 1 example of

LAMINATED INDUSTRIAL PLASTICS *AT WORK*

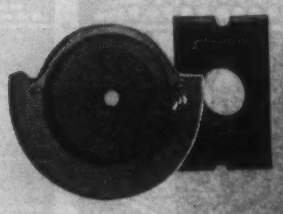
What are the *practical* facts about new uses for industrial plastics? Where have war uses actually proved plastics to be permanent and better replacement materials—not substitutes, nor "materials of the future?"

MICARTA provides authoritative, factual answers to these questions. MICARTA has countless uses yet unknown—but tangible facts about its performance in almost any use can be found in current, existing applications. MICARTA is the number one example of industrial plastics *at work* . . . the product of the largest laminators of industrial plastics—Westinghouse.

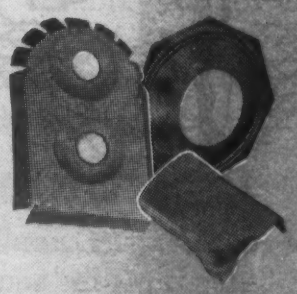
The uses of MICARTA shown here are but a few of thousands. Performance data on many, such as MICARTA aircraft applications, dates from as long ago as 1917. The length and breadth of this experience in the practical application of plastics provide an unequalled fund of facts to guide designers and engineers.

Essential facts about MICARTA are contained in the new MICARTA Data Book B-3184-A. Ask for your copy. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N.

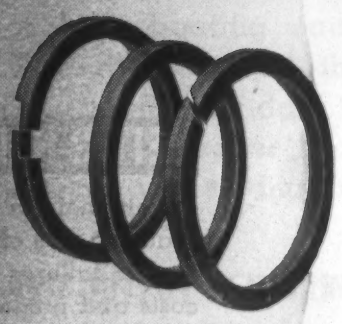
J-06348



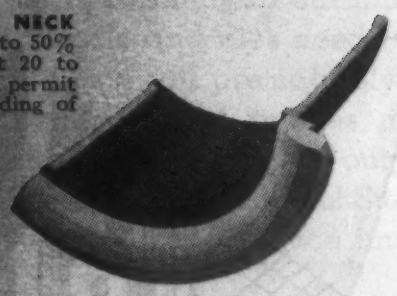
AIRCRAFT PARTS like guides, spacers, brackets are made of Micarta because of lightness, high strength and resistance to wear and corrosion.



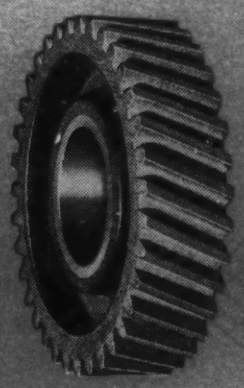
MICARTA "444" is the new thin sheet Micarta that can be quickly, easily formed into intricate shapes with inexpensive wooden dies. Now used in many aircraft applications.



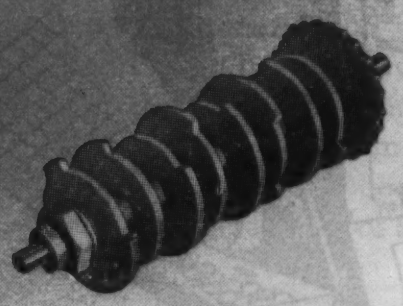
PUMP RINGS made of Micarta do not soften in service, wear slowly, and will not score cylinder walls.



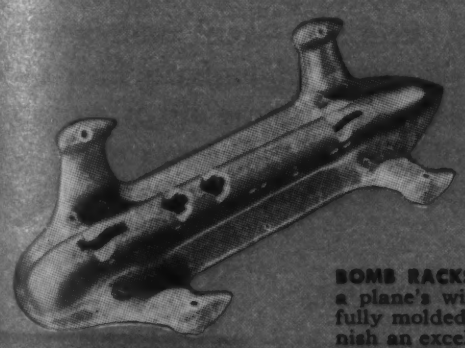
STEEL MILL ROLL NECK BEARINGS save 25 to 50% power cost . . . last 20 to 40 times longer . . . permit more accurate holding of gauge.



GEARS made of Micarta absorb vibrations, resist wear, and cushion repeated shocks without deterioration.



INSULATION PROBLEMS of all types have been solved with Micarta—a $\frac{1}{16}$" thick piece withstands 62,000 volts!



BOMB RACKS to hold bombs under a plane's wings have been successfully molded of Micarta. They furnish an excellent example of Micarta's great strength and adaptability to intricate molded shapes.

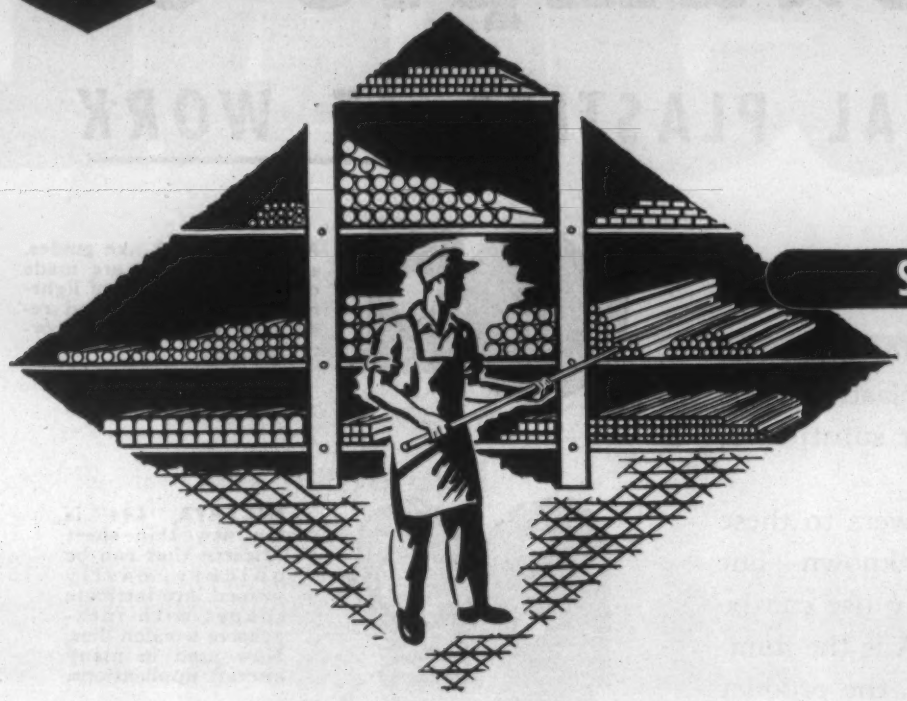
AIRCRAFT FAIRINGS formed from flat sheets provide needed strength with less weight than aluminum.

Westinghouse

Micarta

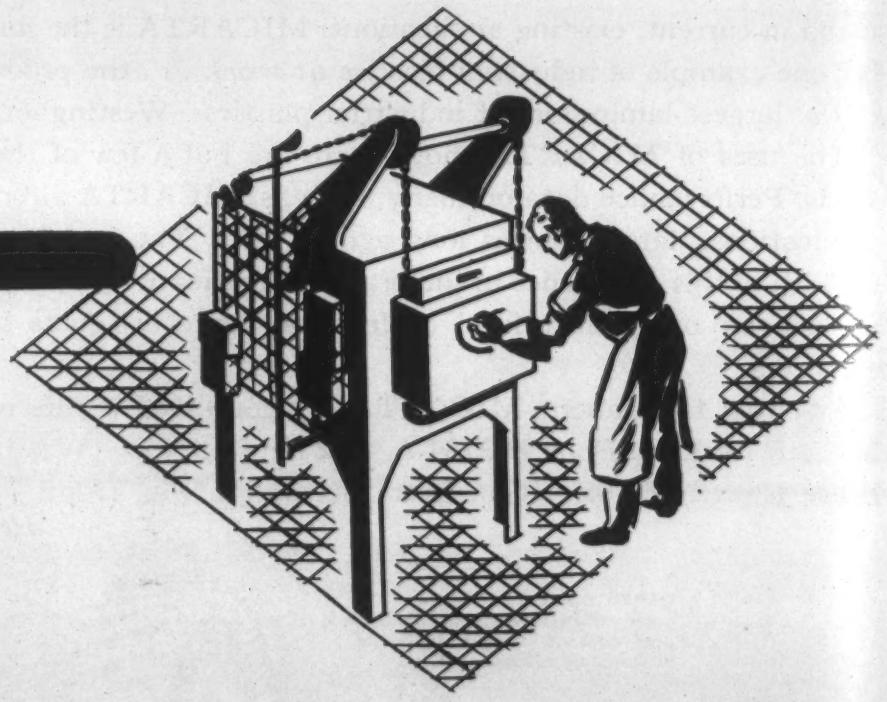
THE INDUSTRIAL PLASTIC

Only Carpenter offers this 3-Way Program....



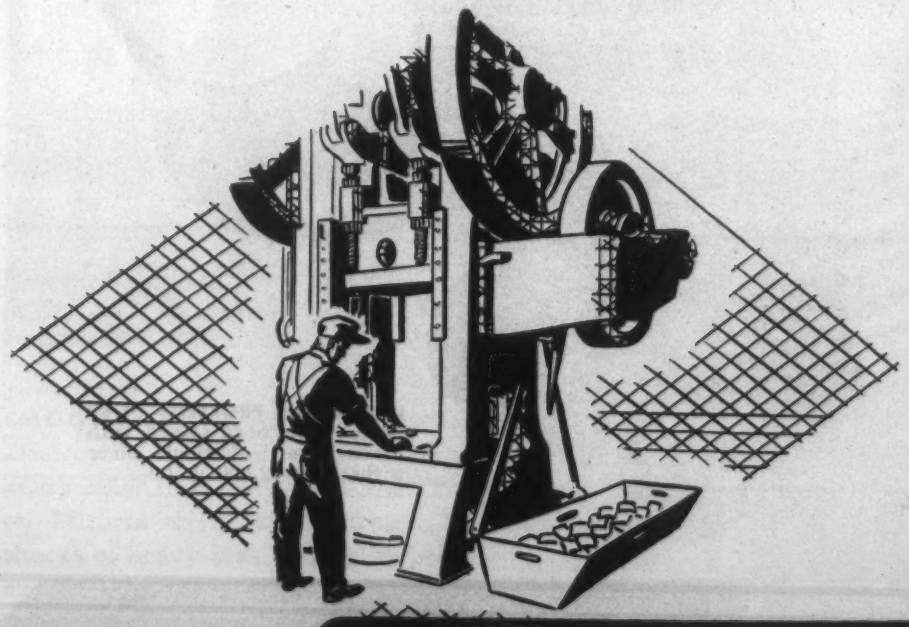
SAFER METHOD OF SELECTION.....

A method of tool steel selection that reduces inventories and guides you to the tool steel that will give you maximum tool life for a specific job. Saves tool room time and helps you to plan your tool performance.



BETTER HARDENING RESULTS.....

Definite help in overcoming hardening troubles, cracking, size change, distortion, and premature service failures that contribute to excessive tool costs and production holdups.

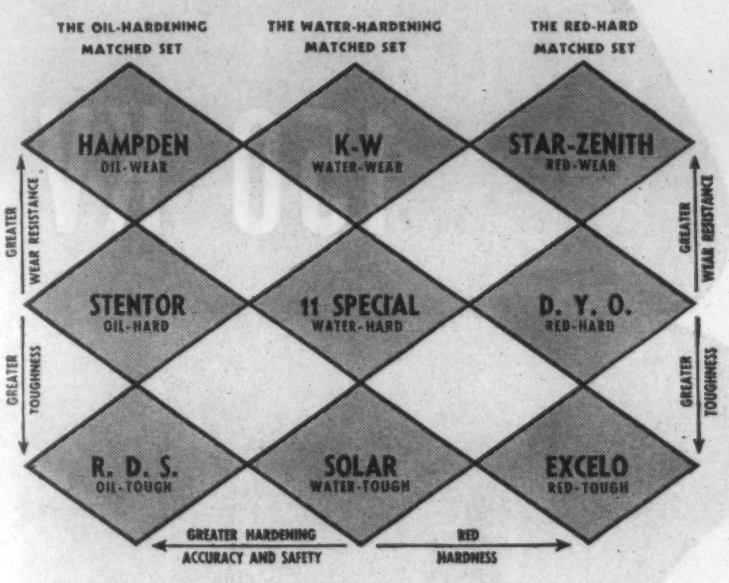


MORE PRODUCTION PER GRIND.....

First-aid procedure for curing tool-caused interruptions to machine output. Tools that stay on the job longer between grinds, mean fewer shutdowns and lower unit costs.

The Standard Tool Steels of Industry

to REDUCE UNIT COSTS by Better Tooling



Key to the Carpenter program of cost reduction —simplified selection with Carpenter Matched Tool Steels—and a method that guides you to maximum tool life.

Your company along with many others is faced with the problem of finding new ways to cut unit costs. Reconversion and competition will make it necessary. Better tooling is one very good way to show quick results.

The Carpenter 3-way program makes it easy to get better tooling *fast*—and bring about savings in tool costs and production costs. War plants found this program a life saver in boosting war output. Now, this same program will help to speed reconversion and bring needed cost reductions.

1 SELECTION OF TOOL STEEL ON PERFORMANCE

The Carpenter Matched Set Method simplifies selection. It guides you to the proper tool steel for each job—the steel that will give you the required combination of properties for maximum production performance. You can actually predetermine performance when you work with Carpenter Matched Tool Steels.

2 COMPLETE HEAT TREATING PROCEDURE

Clear, simple, easy-to-follow, printed instructions are provided for heat treating each Carpenter Matched Tool Steel, to get the desired results. A new slide chart with this data is now supplied for your heat treaters. Proper heat treatment assures safe hardening and savings in tool making costs.

3 CHECK ON TOOL LIFE AND OUTPUT PER GRIND

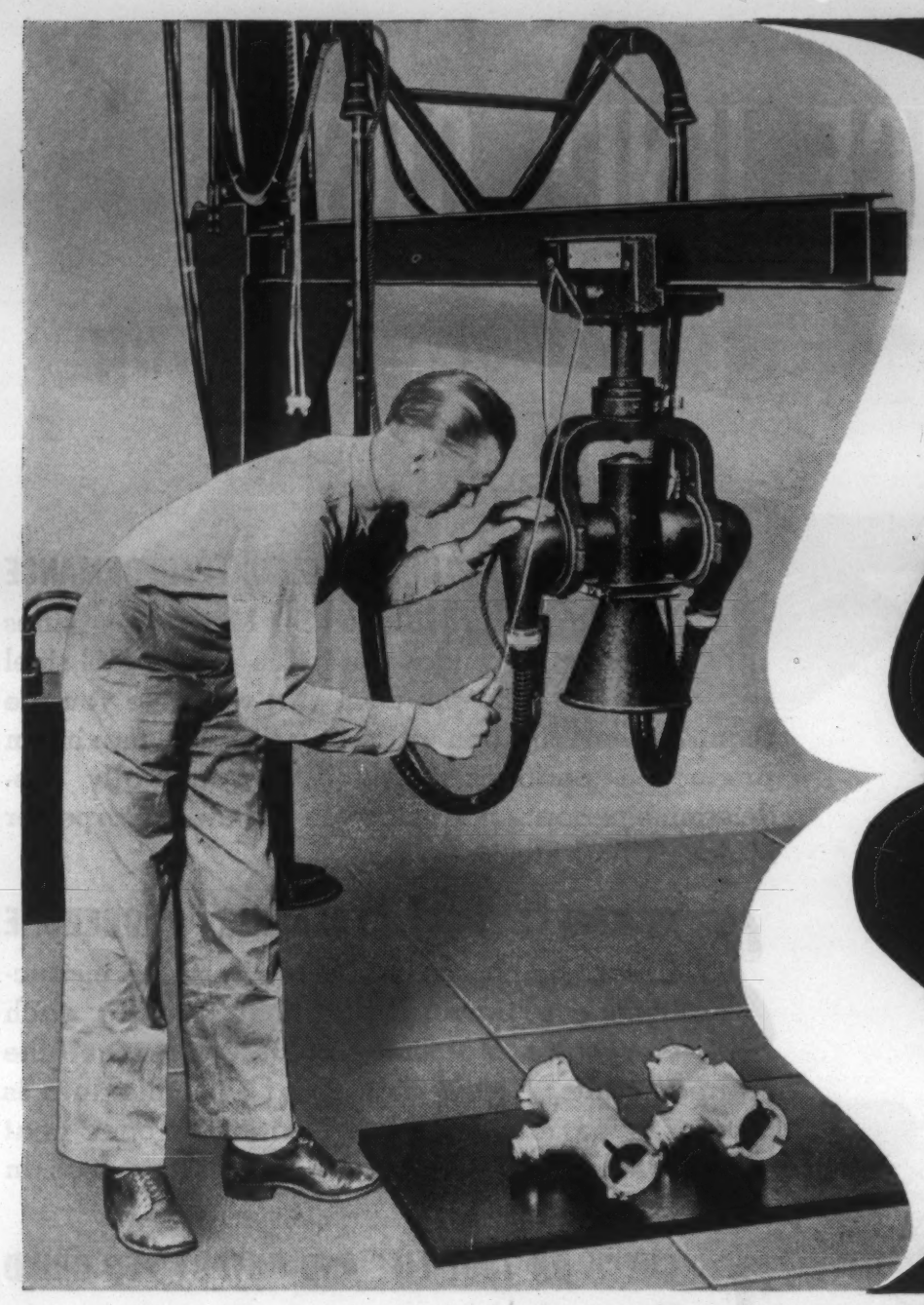
Here is the big opportunity to cut unit costs. Find out which tools and dies need frequent regrinding, or which fail prematurely in service. Every time machines and presses must be stopped to tinker with tools—it interrupts output and raises unit costs. Carpenter Matched Tool Steels can help you lick this condition, and reduce unit costs.

How to get started on this cost reduction program: Send for the Matched Tool Steel Manual. It contains heat treating instructions for each steel, and an 80-page tool index and steel selector. Write for a copy today on your company letterhead indicating your title. (Free to tool steel users in U.S.A.)

THE CARPENTER STEEL COMPANY • 135 W. Bern St., Reading, Pa.

Carpenter MATCHED TOOL STEELS

BRANCHES AT Chicago, Cleveland, Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia



Westinghouse new 150 KV

The new Westinghouse 150-Kv Industrial X-ray Unit is the result of years of research in industrial x-ray equipment of medium voltage. Within its range, it is the most powerful industrial x-ray equipment available. Using practical exposure times, it is capable of efficiently examining, with screens, 1½″ of steel . . . 1″ of brass . . . 7½″ of aluminum.

With the new Westinghouse 150-Kv, sand castings, die castings, welds, spot welds, wood, plastics, ceramics and all types of electrical and mechanical assemblies can be examined simply and quickly. It is ideal equipment for foundry, welding shop, pipe shop and all industrial applications.

A choice of two tubestands is available for the new Westinghouse 150-Kv Industrial X-ray Unit. The most popular tubestand has a carriage that can be positioned at any height within its 33″ to 66″ target-to-floor distance. It is suitable for the majority of industrial applications. For x-raying large products, a jib crane tubestand is offered which permits a target-to-floor distance from 18″ to 72″ in a 10-foot ceiling room.

Call your nearest Westinghouse Office for details. Remember, saying "it's x-ray tested" will be a valuable postwar competitive advantage. Westinghouse Electric & Mfg. Co., Box 868, Pittsburgh, Pa.

Westinghouse INDUSTRIAL X-RAY

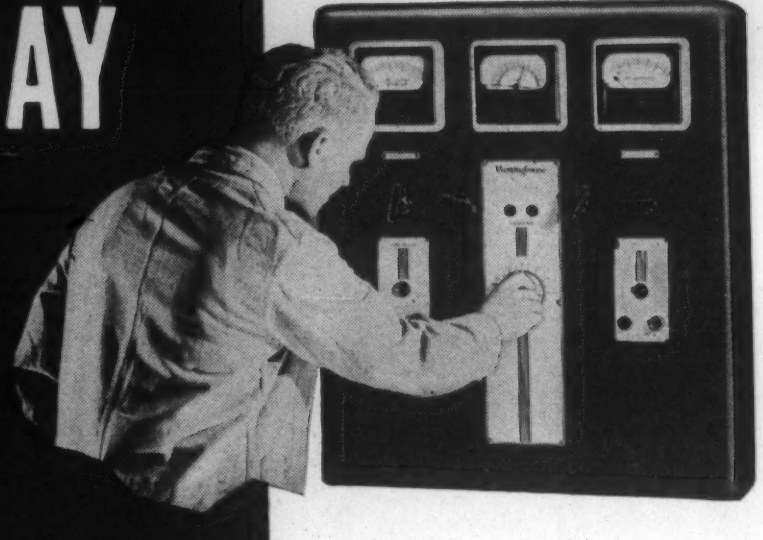
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

announces . . .

INDUSTRIAL X-RAY

with X-ACTRON

one of the foremost achievements in the design of x-ray controls



The new Westinghouse 150-Kv Control with X-Actron eliminates guesswork usually associated with milliamperage selection and maintenance. After the milliamperage is chosen, X-Actron, an electronic stabilizer, brings the milliamperage to the desired level and keeps it there for the duration of the exposure.

Constant milliamperage is maintained regardless of fluctuations in line voltage. Operating kilovoltage and other unstable fluctuations do not affect the X-Actron. In fact, the entire operation of the apparatus is so simplified that operational instructions are reduced considerably.

In addition, the new Westinghouse 150-Kv Control is the only x-ray control on which kilovoltage can be accurately read directly. The control also contains an electrically driven x-ray timer with its entire scale divided into hundredths of minutes. This division of scaling simplifies the calculation of exposure timing since most technique charts are developed in milliampere minutes.

This "years ahead" x-ray control is standard equipment with the new Westinghouse 150-Kv Industrial X-ray Unit. Full details are available from your nearest Westinghouse Office. J-08096

LOOK INSIDE WITH WESTINGHOUSE **X-RAY**

VICTOR

ARMY E NAVY

for

FLAME PRIMING & DESCALING

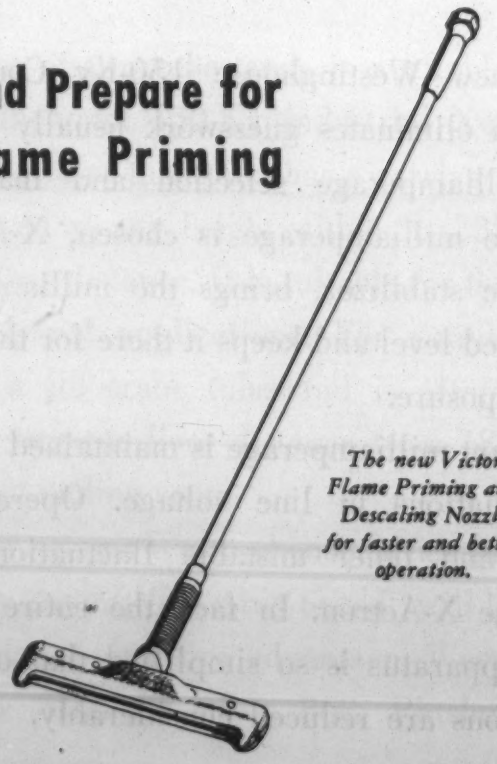
The Modern Method to Remove Rust Scales and Prepare for Subsequent Painting Is Descaling and Flame Priming

The process of descaling and flame priming is now established. To simplify these operations, we respectfully introduce the new Ribbon Flame Descaling and Flame Priming Torch. The standard models are obtainable in 4″ (No. 361) and in 6″ (No. 362) flame width.

Replaceable Meehanite skid shoes, *Airadiator* cooling section, and built-in *Spiral Mixer* and *Gas Proportioner* assure long service life, freedom from back-firing and best obtainable flame characteristics.

For inaccessible places or rivet heads, Circular Multi-Flame Nozzles are available.

VICTOR welding torch owners require only the attachment.



The new Victor Flame Priming and Descaling Nozzle for faster and better operation.

VICTOR EQUIPMENT COMPANY

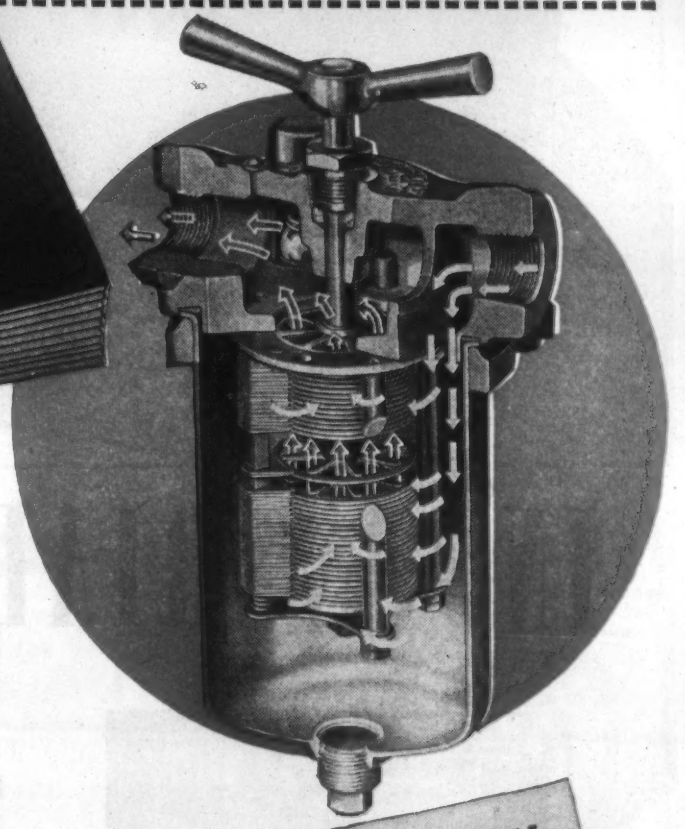
844 FOLSOM STREET · SAN FRANCISCO 7

Ad No. 82

DISTRIBUTING POINTS FROM COAST TO COAST

Can Cuno Cure Costly Time Waste In...

Cleaning Fluids?



IF you handle any pumpable liquids — from tar to water — you know that TIME is the largest single factor in production costs. "Quick Facts", Cuno's new free booklet, shows how this profit-eater can be cut down to size by using a non-stop filter that *cleans continuously* and at the same time is *continuously cleanable* without interrupting fluid flow. Your copy is ready now. Send the coupon.

"QUICK FACTS", the 36-page booklet written for you by Cuno Engineers, deals with the solution of 44 specific liquid-filtering problems, and suggests the solution to many others. Packed with practical ideas, illustrated applications and diagrams, it delivers to your desk filter information gathered from all parts of industrial America.

YOU WILL SEE HOW CUNO "FILTER-FINE" STRAINERS

1. are cleanable in action — without interruption of fluid flow.
2. handle full flow, yet are no larger than ordinary partial-flow-type.
3. are non-susceptible to the delays and failures of ordinary screening.
4. have low pressure drop.
5. are all-metal, non-collapsible, permanent.
6. are built in a wide range of sizes and metals.

APPLICATIONS INCLUDE SUCH A VARIETY AS

- Greases & lubricants
- Chemicals & soaps
- Paints, coatings & finishes
- Hydraulic control systems
- Fuel oils
- Water in actuation of combustion meters
- Roll body coolants on cold strip mills
- Degreasing and rust-proofing compounds
- Recirculating quenching oil systems
- Foods & beverages
- River water
- And many others

KEEP FLOW ON "GO" WITH

CUNO

THE "FILTER-FINE" STRAINER

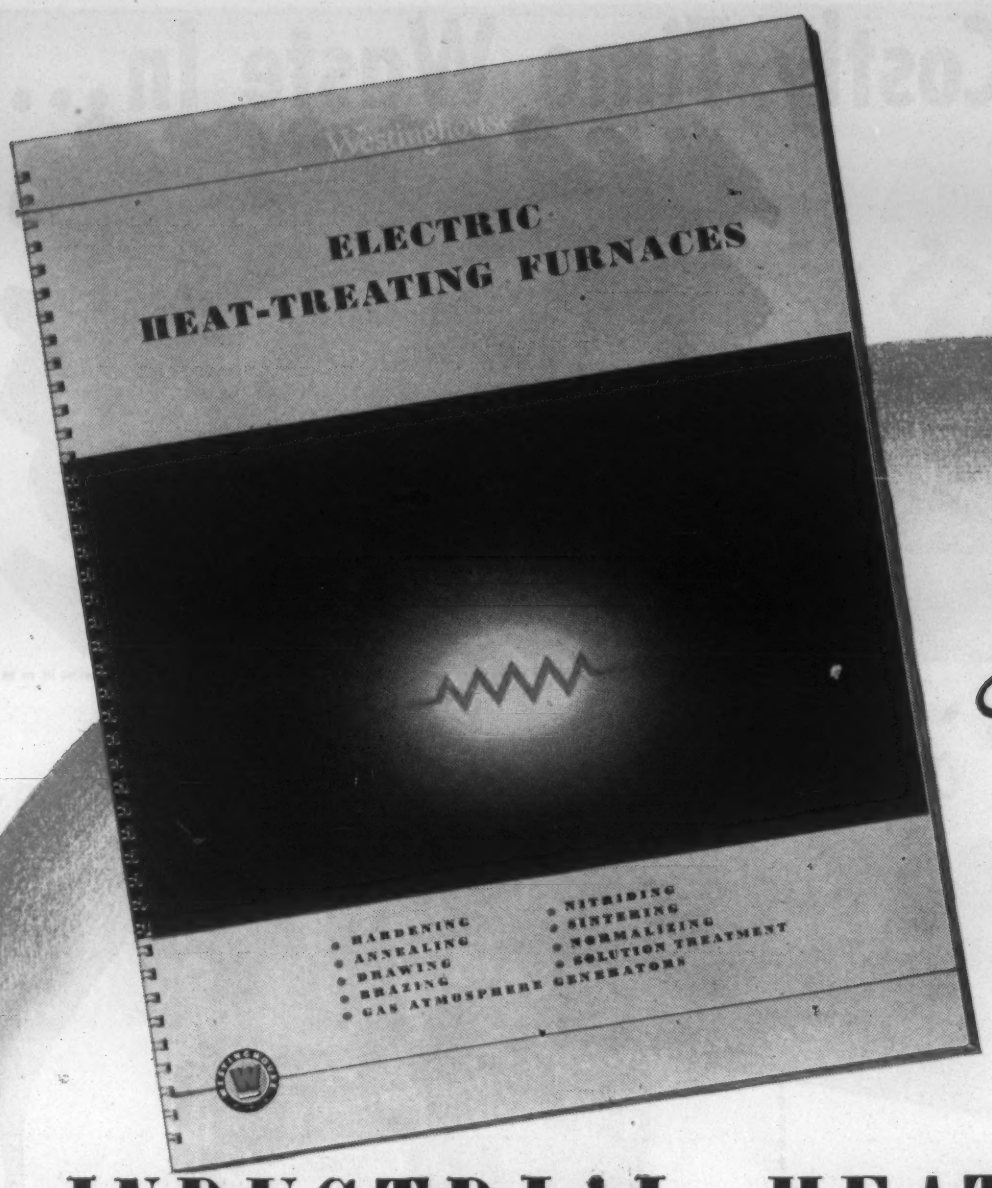
CUNO ENGINEERING CORPORATION
462 South Vine Street
Meriden, Conn.

Please send me a free copy of "QUICK FACTS"

NAME .....

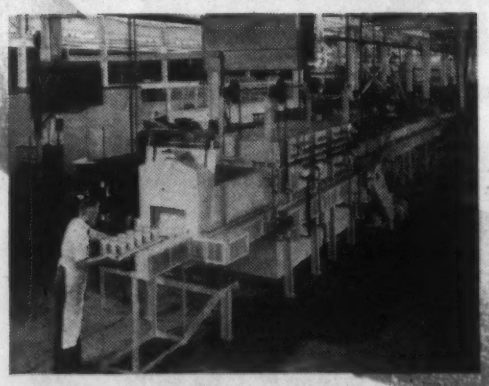
COMPANY .....

ADDRESS .....

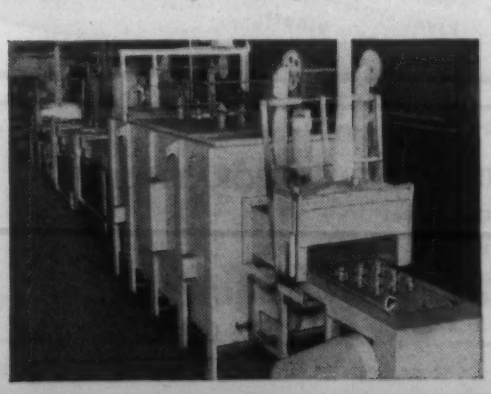


Here's new help on every type of

INDUSTRIAL HEAT-TREATING



This continuous roller hearth furnace is ideal for production-line bright annealing, copper brazing and sintering. It is built for either manual or automatic charging or discharging. Exogas is used for low carbon parts and Endogas for medium and high carbon parts.



Continuous belt conveyor furnace used for copper-brazing lightweight ferrous assemblies in Exogas atmosphere. This furnace is suitable for brazing various types of small machine or pressed parts, and also for annealing and sintering.

There's new help in this book on modern Westinghouse electric heat-treating furnaces for every type of industrial heat-treating, either small-lot or production-line work.

Used with the proper atmospheres, Westinghouse furnaces sharply reduce machining and cleaning operations in most cases and their precise control virtually eliminates rejects. Product uniformity is assured.

The experience of practical Westinghouse engineers is available now to help solve your problems in any type of heat-treating . . . both furnace and atmosphere applications. Westinghouse electric furnaces for the most common applications are described in booklet B-3281. The four basic atmospheres—Endogas, Exogas, Monogas and Ammogas—are covered in descriptive booklet, B-3251.

Ask your nearest Westinghouse office for your copies of these two books, or write Westinghouse Electric & Mfg. Co., P. O. Box 868, Pittsburgh 30, Pa. J-10270

Westinghouse

Electric Heat-Treating Furnaces

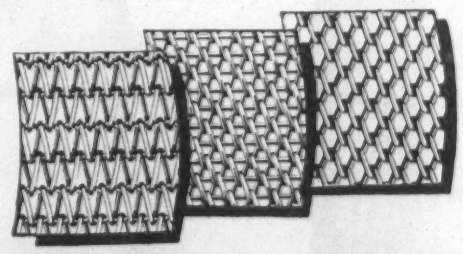
"Say J. B, he handles things almost as smoothly as our W. S. Conveyor Belts."

You can handle more Production—more Efficiently!

When Wickwire Spencer Flexible Metal Conveyor Belts are released for peacetime production, many new industries will want to take advantage of their cost-cutting benefits. For these highly efficient belts not only reduce handling costs—they speed production and insure more uniform results.

Wickwire Spencer Conveyor Belts are custom-engineered. They are built to give greatest load capacity per unit of weight; to operate efficiently at temperatures as low as —40° F. or as high as 2100° F.; to give long service under chemical action, extreme temperatures and other destructive forces. Belts can be fabricated in widths from 1" to 192"—in steels, brass, bronze, monel and various heat resistant alloys.

Write for our valuable reference book showing types and advantages of numerous conveyor belt constructions and weaves. Also pictures of many actual installations. Write to the Mechanical Specialties Division, General Sales Office and Plant, Sterling St., Clinton, Mass.



CONSIDER WEAVE

Prime consideration in drying and temperature applications is *free air circulation*. In washing *free drainage* is necessary. Wickwire Spencer Belts are available in several different weaves to suit specific needs.

WHERE THEY ARE USED

Annealing Ovens
Baking Ovens
Brazing Furnaces
Chemical Processing
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Dehydrating Food
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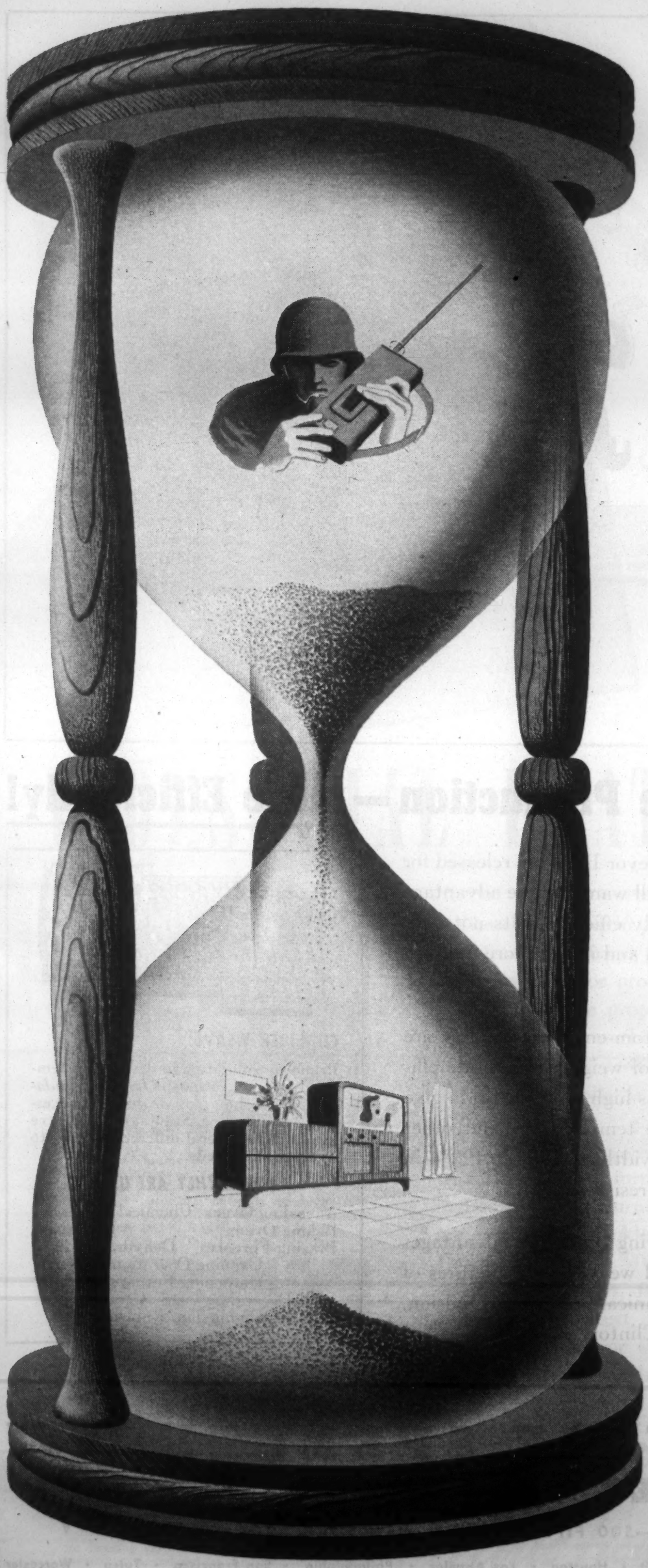


WILCO facilities Expanded to Meet Wartime Needs!

But Postwar Industry will be the ultimate gainer from the many new WILCO products and developments

As the Hourglass indicates . . . at the coming of peace, the skill and experience gained in the development and application of new WILCO products and techniques will mean much to automotive, electrical appliance and many other types of manufacturing customers.

Though now chiefly applied to the war effort, these new WILCO developments are destined to play as vital a role in the postwar industrial "comeback" as they are now playing in scores of wartime applications.

Thermostatic Bimetals, Electrical Contacts, and Precious Metal Bimetallic Products are such important factors in the precision performance of ships, planes, tanks, guns, and various instruments of the Army and Navy that the H. A. Wilson Company has found it necessary to enlarge its facilities and develop these important new products and techniques.

In the postwar period no company will be better equipped to meet individual requirements for Thermostatic Bimetals and Electrical Contacts on any desired scale than the H. A. Wilson Company, pioneers in this field.

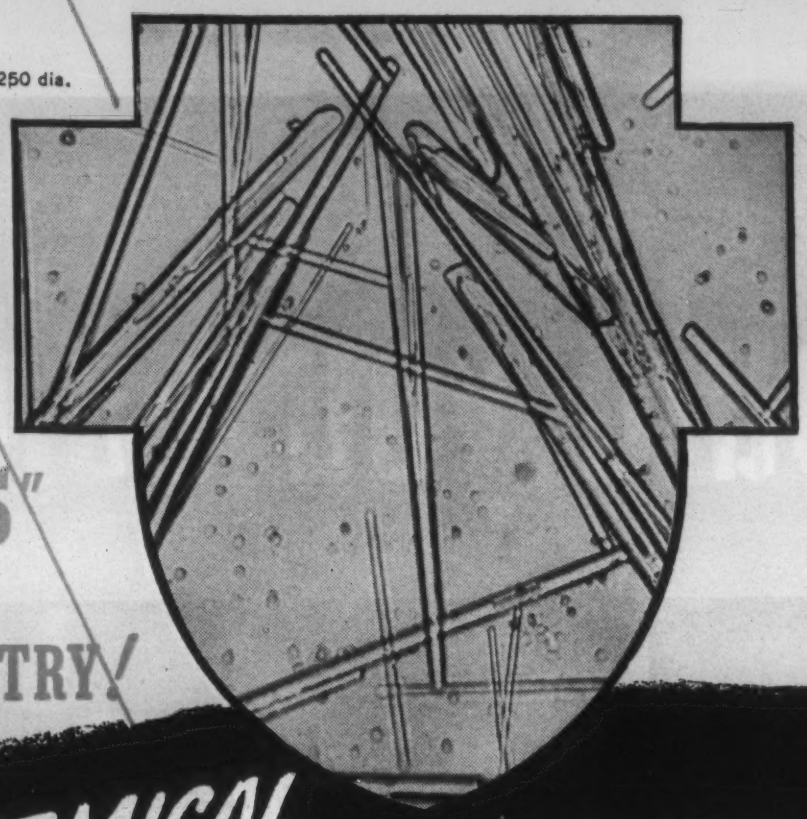
WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel. Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested. *Rolled Gold Plate.* Special Materials.

THE H. A. WILSON COMPANY
105 Chestnut Street, Newark 5, New Jersey

WILCO

Thermometals—Electrical Contacts
Precious Metal Bimetallic Products

NEW CHEMICAL "TOOLS" FOR AMERICAN INDUSTRY!



Growing crystals of lead fluoborate—250 dia.

METAL FLUOBORATES

- Cadmium Fluoborate
- Chromium Fluoborate
- Copper Fluoborate
- Ferrous (Iron) Fluoborate
- Indium Fluoborate
- Lead Fluoborate
- Nickel Fluoborate
- Silver Fluoborate
- Stannous (Tin) Fluoborate
- Zinc Fluoborate

Alkali Group

- Ammonium Fluoborate
- Potassium Fluoborate
- Sodium Fluoborate

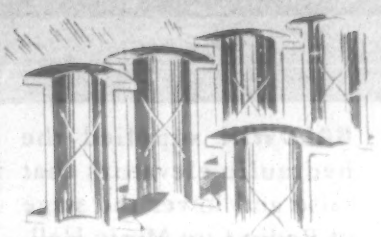
GENERAL CHEMICAL METAL FLUOBORATES

Many important products have been developed out of General Chemical's progressive research in fluorides. *Today*—its Metal Fluoborates command considerable attention as new chemical "tools" for electroplaters and metallurgists. *Tomorrow*—the unique properties of these versatile chemical compounds suggest many potential uses whose development is both a challenge and a promise of rich reward to research and industrial chemists interested in electrolytic and metallurgical processes.

ELECTROPLATING – Metal Fluoborates are supplied in a concentrated solution form. They require no time to dissolve and dilute quickly with water to the required plating strength! Laboratory tests and commercial applications indicate that the Metal Fluoborates have other outstanding advantages for electroplating, such as high anode and cathode efficiency, good conductivity, high concentration and ease of operation at room temperature.

At present there is a widespread acceptance of lead fluoborate plating baths and an ever-growing use of lead-tin, tin, zinc, cadmium, indium, copper and other Metal Fluoborate solutions.

METALLURGY – Magnesium and aluminum casting has opened a field where alkali fluoborate salts are extremely important. All these salts may find acceptance as fluxes for welding and soldering such metals as silver, gold, stainless steel, nickel, etc. Their further use by metallurgists for heat treating, hardening and other processes can be expected with new developments in the light metal field.



Indium and Lead Fluoborate Give Airplane Bearings Longer-Wearing Surfaces.

Metal Fluoborates Efficient in Barrel Plating, too.

Alkali Fluoborates Important in Magnesium and Aluminum Casting.

GENERAL CHEMICAL COMPANY ...FIRST IN FLUORIDES

GENERAL CHEMICAL COMPANY

40 RECTOR STREET, NEW YORK 6, N. Y.

Technical Service Offices: Atlanta • Baltimore • Boston Bridgeport (Conn.) • Buffalo • Charlotte (N. C.) • Chicago Cleveland • Denver • Detroit • Houston • Kalamazoo (Mich.) Kansas City • Milwaukee • Minneapolis • New York Philadelphia • Pittsburgh • Providence (R. I.) • St. Louis Utica (N. Y.) • *Pacific Coast Technical Service Offices:* Los Angeles • San Francisco • Seattle, Wenatchee, Yakima (Wash.)

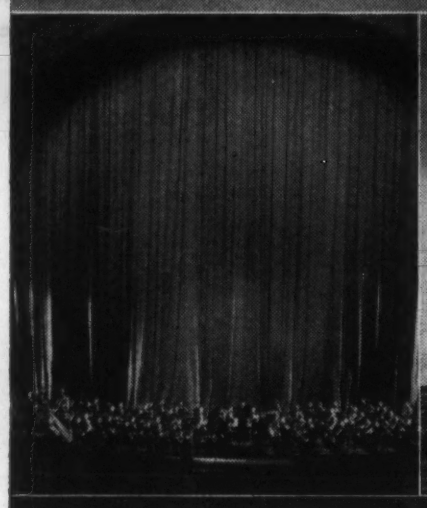
In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

JUST RELEASED!

Important new research data on General Chemical Metal Fluoborates. Includes plating with Lead, Tin, Zinc and Cadmium Fluoborate, etc. Ask for Technical Service Bulletin No. 1015-A.

Copies on request from: Nearest Technical Service Office or General Chemical Company, Fluorine Division, 40 Rector Street, New York 6, N. Y.

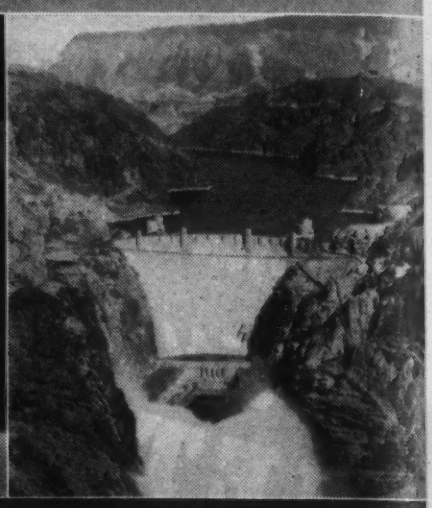
Would you believe it?



BALDWIN supplied the hydraulic elevators that raise and lower the stage of Radio City Music Hall.

BALDWIN diesel engines are used for main propulsion units on minesweepers and for auxiliary power on many other vessels.

BALDWIN testing machine of 3,000,000 pounds capacity can be controlled so as to break the shell of a hatching egg without harming the chick.



BALDWIN hydraulic turbines, 115,000 horsepower capacity, driving huge electric power generators, are installed at Boulder Dam.

Baldwin manufactures a wide diversity of products, including testing equipment for wind tunnels, steering gears for LST landing craft, hydraulic elevators for aircraft carriers, and many other machines and instruments, serving industry on which America is depending to speed final victory.

Of course, Baldwin is well known as the builder of locomotives of all types—steam, diesel-electric and electric—doing their share of the greatest transportation job in history.

BALDWIN

BLW THE BALDWIN GROUP

The Baldwin Locomotive Works, Philadelphia, Pennsylvania: Locomotive & Ordnance Division; Baldwin Southwark Division; Cramp Brass and Iron Foundries Division; Standard Steel Works Division; The Whitcomb Locomotive Co.; The Pelton Water Wheel Co.; The Midvale Co.

THE BAZOOKA

BRAZED and HARDENED By Electronic Heating

The history of the "bazooka" is one of the outstanding success stories of this war. Just as outstanding is the part electronic heating has played in its manufacture.

Made in two sections for easy portability, the barrel of the gun is jointed in the middle with flanged collars and three locking lugs.

One collar is brazed to the front section at the rate of 120 per hour. Four brazes are made simultaneously, on four separate bazookas, with *one* G-E 15-kw electronic heater. Another identical heater is used to braze the other collar to the rear section.

After brazing, the locking lugs are hardened in a third G-E 15-kw heater at the rate of 375 lugs, or 125 bazookas, per hour. Both the heating and the quenching cycles are automatically controlled.

This is another example of the way electronic heating is helping to speed war production. With this versatile process, you can braze, harden, anneal, or solder—and the heated zone can be confined within close limits. For details, simply contact the nearest G-E office, or write to General Electric Company, Schenectady 5, N. Y.

THIS MULTIPLE FIXTURE is used to harden the lugs on four barrels simultaneously. First, one lug on each barrel is heated and quenched. Then each barrel is rotated to place the lug in position within the heater coil, and the operation is repeated. The same procedure is followed to harden the third lug. This one heater, and one operator, perform the hardening operations on 125 bazookas per hour.

THREE G-E ELECTRONIC HEATERS are used in producing the bazooka, two for the brazing operations, one for hardening.

NO. 9 IN A SERIES OF CASE STUDIES ON THE ACCOMPLISHMENTS OF G-E ELECTRONIC HEATERS

GENERAL ELECTRIC

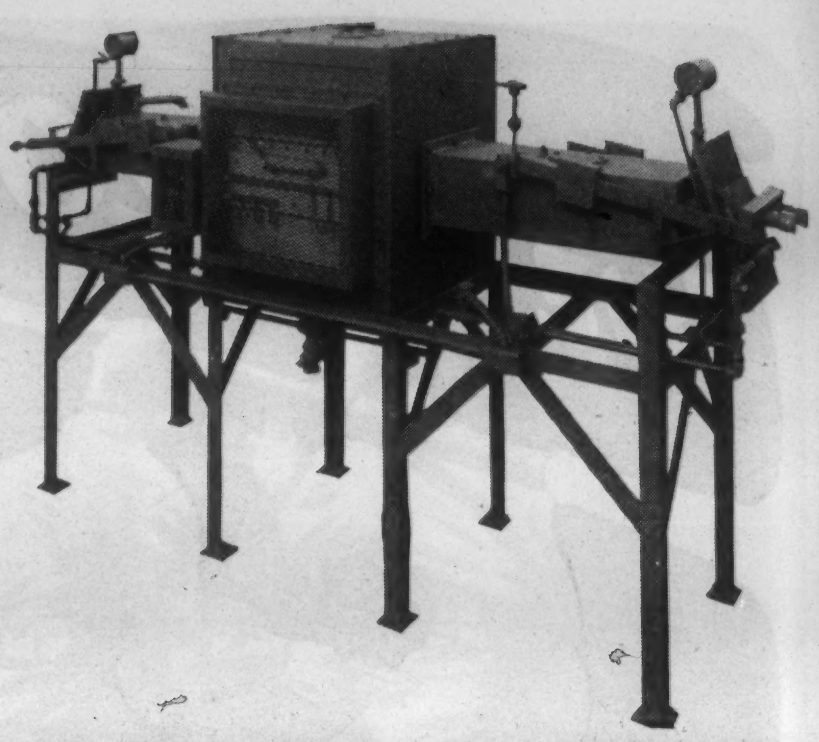
675-98-8709

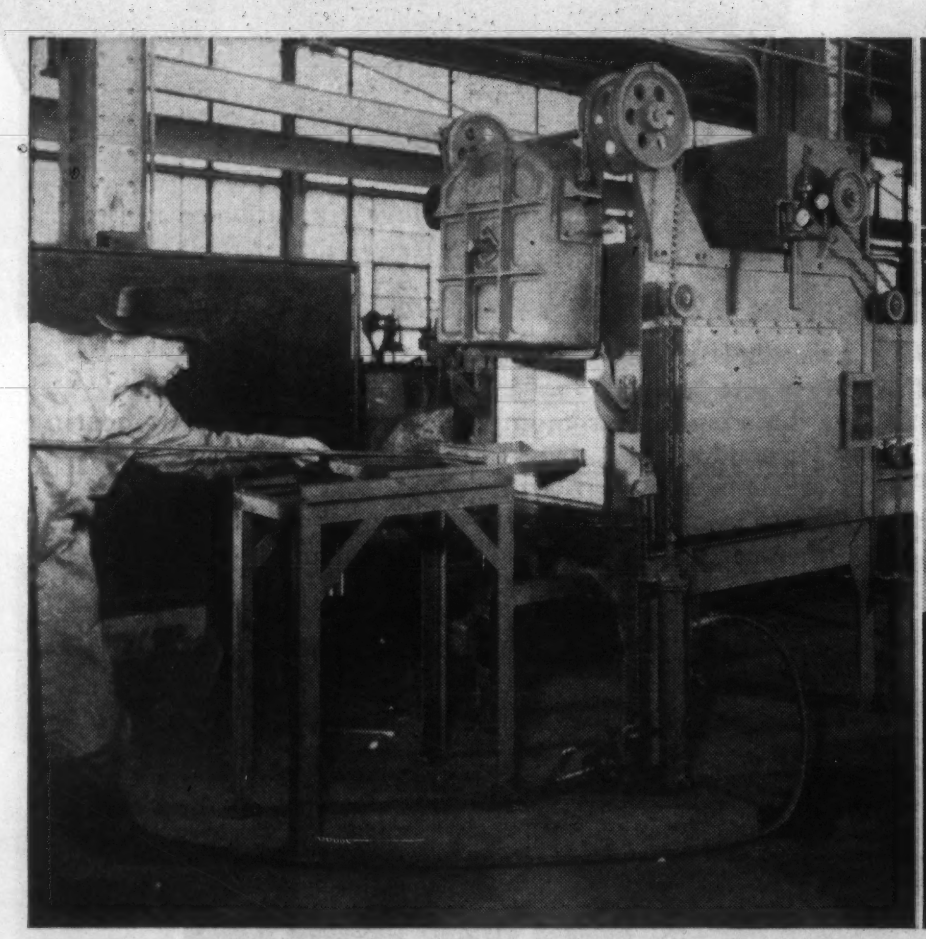
ELECTRONIC HEATERS

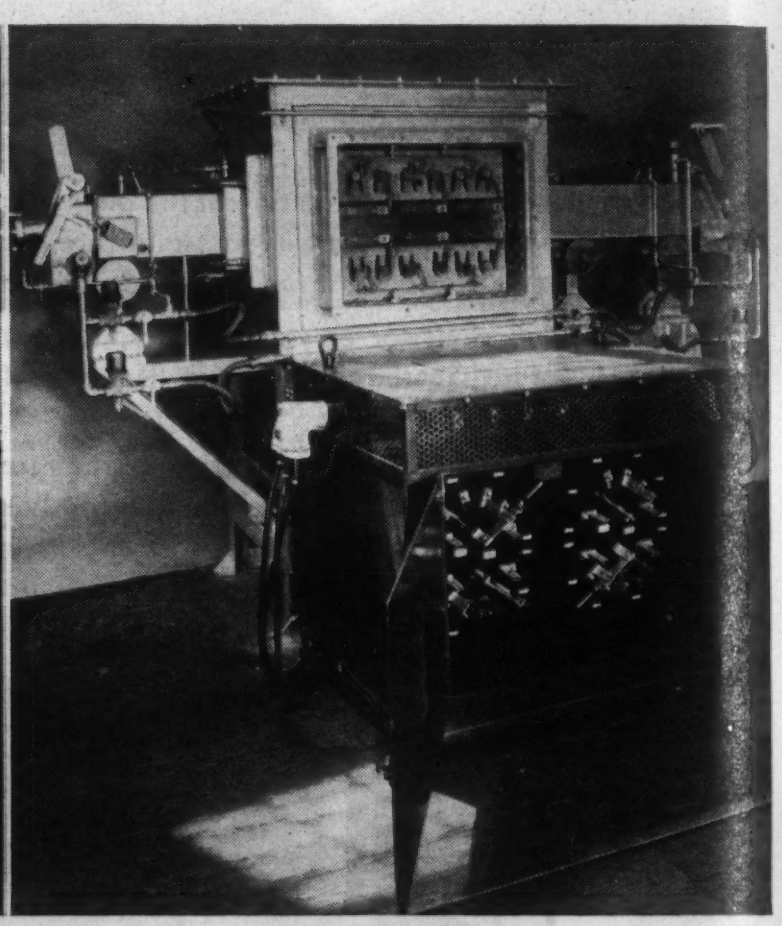
Buy all the BONDS you can—
and keep all you buy

3 MORE POWDER METALLURGY FURNACES

"GLOBAR" POWERED!







These "Globar" equipped high temperature electric furnaces are designed specially for sintering powdered metals, but they are also used for hydrogen brazing, bright annealing of stainless steel parts, reducing metallic oxides and other heating processes where temperatures up to 2750° F. are required. Several factors contribute importantly to the success of these furnaces:

1. Design—resulting from a lot of "know how" in furnace engineering, operation and application.

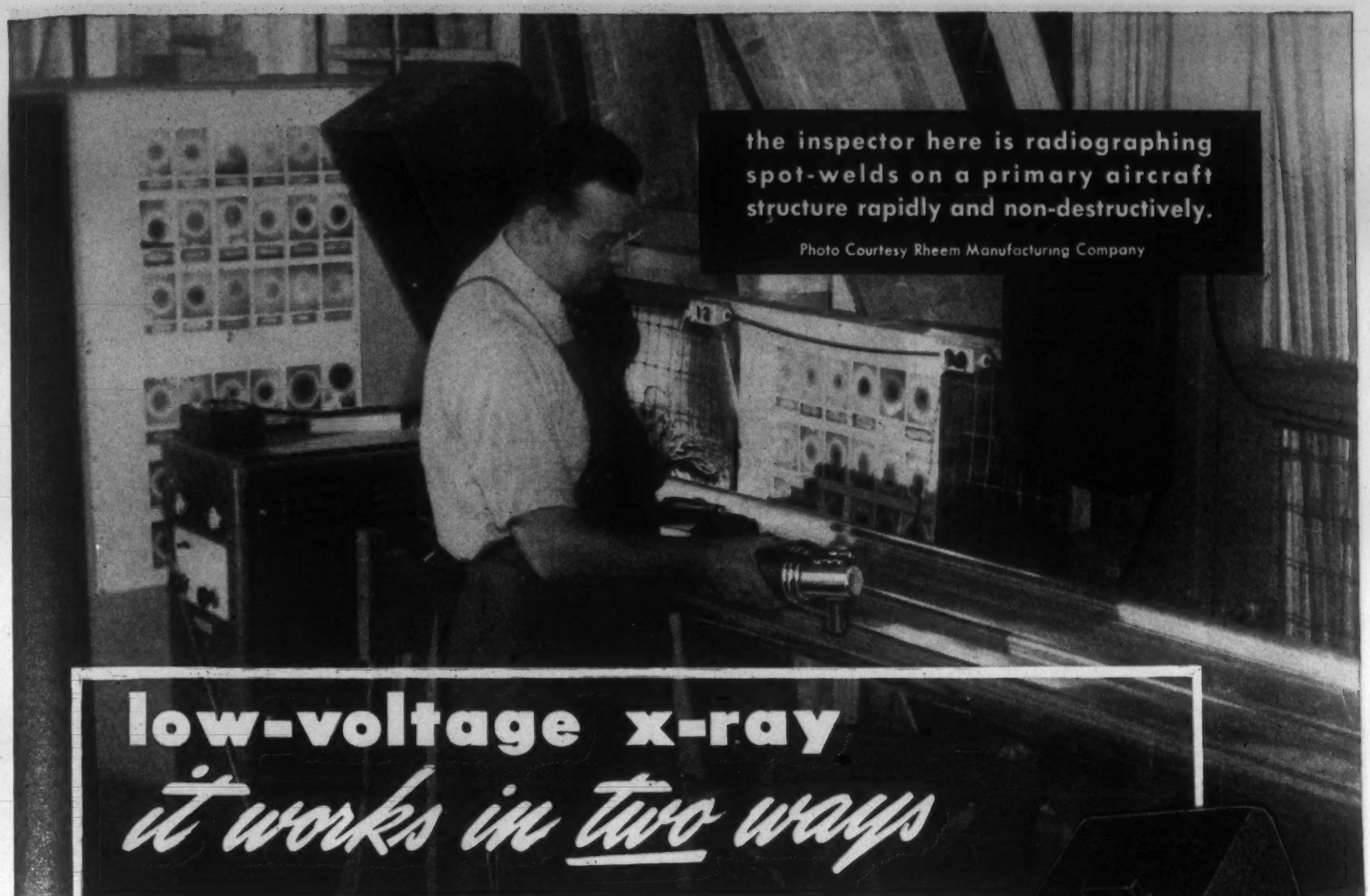
2. "Globar" Electric Heating Elements which insure close control of temperatures ranging between 1800° F. and 2750° F. Independent and accurate control of atmosphere and uninterrupted production.

We do not manufacture furnaces but we do have a wealth of engineering data on many types for high temperature heating applications. Glad to share this information with you. Write our Engineering Department, The Carborundum Company, Globar Division, Niagara Falls, N. Y.

"Globar" Heating Elements by CARBORUNDUM

TRADE MARK

(Carborundum and Globar are registered trade marks of and indicate manufacture by The Carborundum Company)



the inspector here is radiographing spot-welds on a primary aircraft structure rapidly and non-destructively.

Photo Courtesy Rheem Manufacturing Company

low-voltage x-ray
it works in two ways

In light-alloy and steel sheet fabrication, low-voltage x-ray works in *two-ways* . . . it permits (a) setting-up close welding technique controls *before* production spot-welding is done, and (b) accurate inspection of welds *after* the operation. The low-voltage radiograph discloses conditions of stress and weakness far beyond ordinary static-shear tests . . . and does it *non-destructively*.

The virtue of low-voltage x-ray lies in the *higher* radiographic contrast obtainable through *minimum* x-ray penetration. The special output characteristics required for such work are all embodied in this new Picker 5 KV to 50 KV Unit. It is rayproof, compact and self-contained. Several design innovations are incorporated, such as the removable tube shown in the photograph above.

In short, the Picker 5 KV to 50 KV is an ideal apparatus for x-ray investigation and inspection of all low-density materials — metals, plastics, fibres, plywood, textiles, to name a few. A Picker representative will be glad to discuss with you its amazing utility and many applications.

industrial PICKER X-ray

sets the pace in X-ray

PICKER X-RAY CORPORATION • NEW YORK, N. Y.
WAITE M'FG DIVISION • CLEVELAND, OHIO

Air Conditioning helps this theatre put on GREAT shows!

You watch the Jap take a torpedo amidships.

Your eyes strain to catch every changing scene, every detail, every flicker of motion. You see the Jap flounder . . . and sink. This is a *great* show!

Air conditioning not only helped to make those unforgettable pictures clear and sharp and bright . . . it helped make possible *the hit itself!* Because the optical aiming and viewing system used in the periscope of this U. S. submarine was ground and polished to high standards of precision—in an air conditioned workshop.

Tomorrow's air conditioning is being previewed today in war industries, in stratosphere chambers, in penicillin plants, in military installations—wherever wartime applications demand new and improved equipment. After victory this compact, flexible, efficient equipment will be available for *all* business . . . from G-E.

When the time comes, would you like to be one of the first to get information about postwar G-E Air Conditioning? Write: *General Electric Company, Air Conditioning and Commercial Refrigeration Divisions, Section 449, Bloomfield, N. J.*

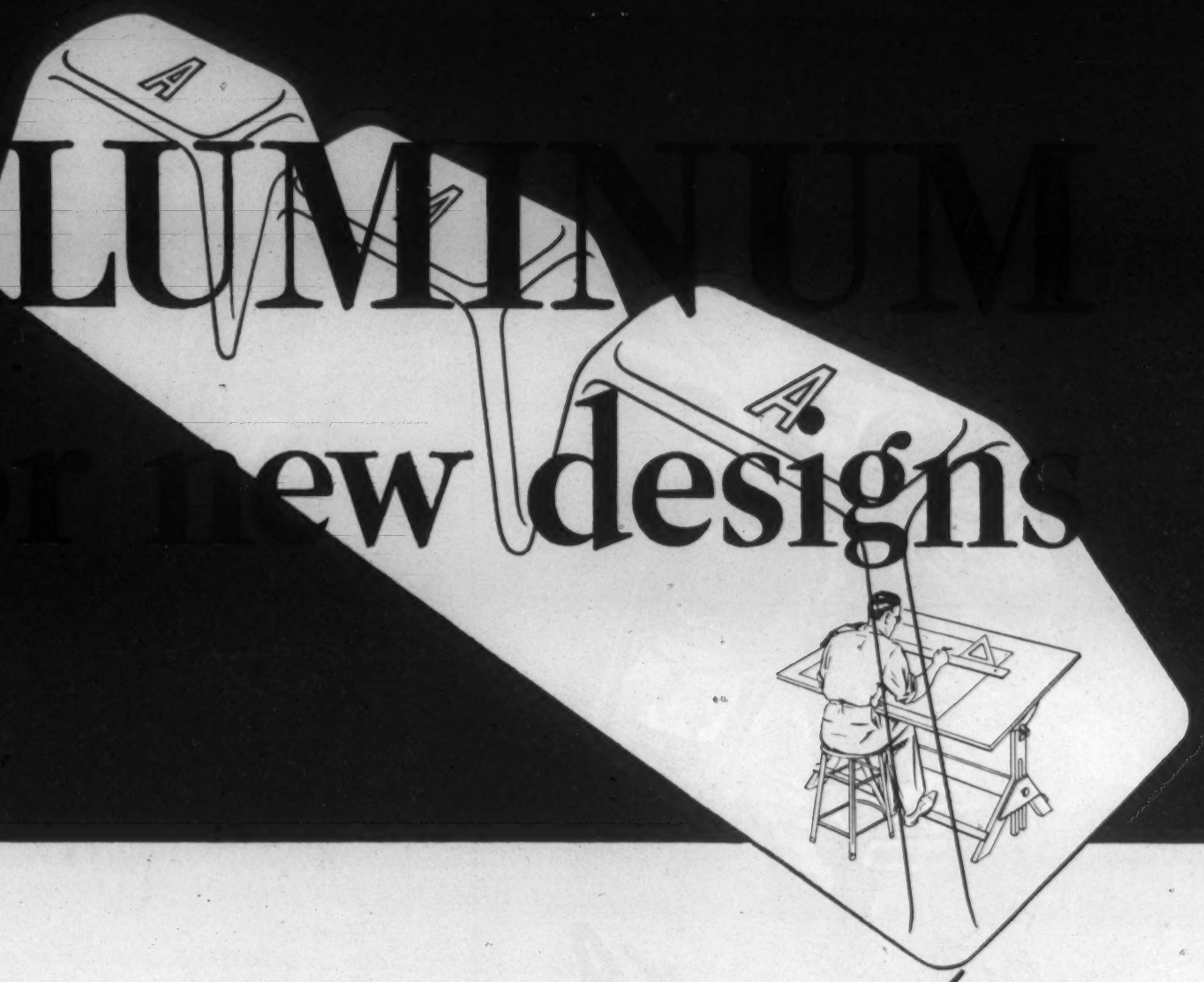
☆ BUY . . and hold . . . WAR BONDS ☆

Air Conditioning by

GENERAL ELECTRIC

Hear the General Electric Radio Programs: The "G-E ALL-GIRL ORCHESTRA," Sundays, 10 p. m., E W T, N B C . . . "THE WORLD TODAY" News, Every Weekday, 6:45 p.m., E W T, CBS.

ALUMINUM for new designs

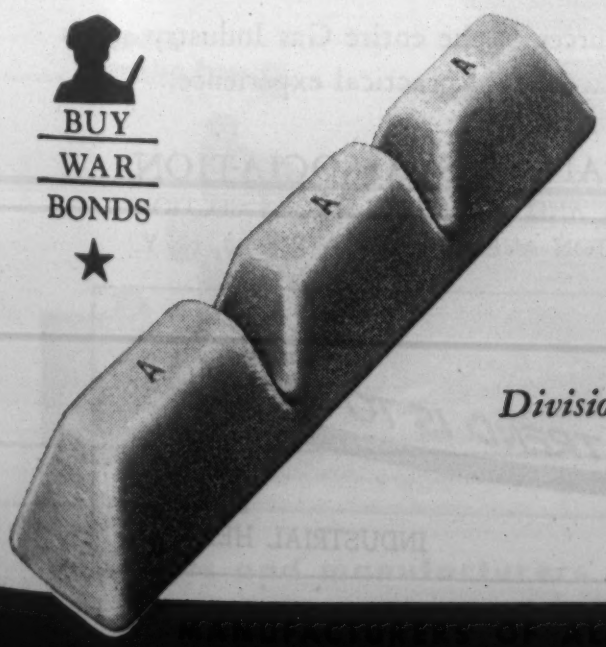


Many of the new products that will emerge from drafting boards in the after-the-war era will call for the use of aluminum.

For aluminum alloys, combining lightness with utmost strength, will present advantages not possible with heavier metals.

Aluminum Refiners — producing accurate analysis alloy ingot in volume — will be ready to serve you. In fact, we can right now, help to supply your requirements for aluminum alloys. We will be glad to discuss the matter with you.

BUY WAR BONDS ★



Aluminum Refiners

Division of **BOHN ALUMINUM AND BRASS CORPORATION**

General Offices: Lafayette Building, Detroit 26, Michigan

Gas is the Industrial Heating Fuel

Bazookas for war or baby carriages in peace call on Gas, the modern industrial fuel for processes requiring heat. Industry at War looked to Gas to solve many production problems. Peacetime plants will find it indispensable.

Gas has a wide range of applications. It is economical, lowers costs. It is clean, accurately controllable, automatic in operation, promotes comfortable working conditions. Gas is fast—it's the answer to the production manager's search for a flexible fuel.

Call in your local Gas Company's Industrial Engineer as a partner in your reconversion problems. He will show you how Gas can help you do a more economical and faster job, while guarding your workers' safety. He has the research resources of the entire Gas Industry at his command, and a wealth of practical experience.

AMERICAN GAS ASSOCIATION
INDUSTRIAL AND COMMERCIAL GAS SECTION
420 LEXINGTON AVENUE, NEW YORK 17, N. Y.

THE TREND IS TO GAS
FOR ALL INDUSTRIAL HEATING

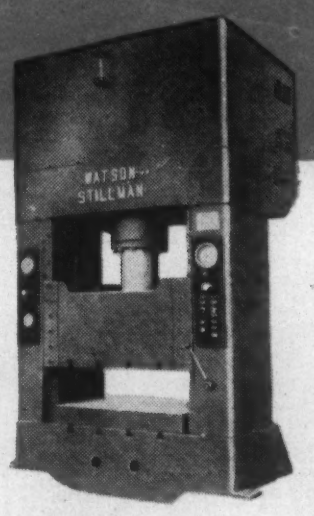
WARTIME metal-working methods FORECAST PEACETIME advances

NEW HYDRAULIC PRESSES developed by Watson-Stillman for fast forming of shells, bombs, airplane propeller domes and fuel tanks, ship plates, and similar products vital to the war effort has added much valuable experience to an already broad "know-how" in designing and building hydraulic equipment for all kinds of metal-forming operations.

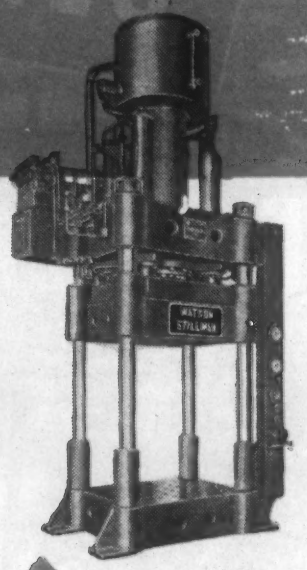
Substantial improvements that have been made by W-S engineers in design and construction of presses, and controls are sure to have a great influence on the economy and wide application of hydraulics in the production of post-war metal products.

The Watson-Stillman Company is fortunately situated—due to its wide scope of war business—in being well posted on postwar possibilities for utilizing hydraulic presses of standard or special design. Its comprehensive line of hydraulic forming presses—built since Pearl Harbor alone—promises wider, more varied metal-working benefits to all major industries in the postwar period.

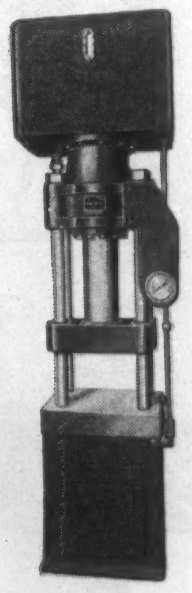
Only a few of the many available types and sizes of latest W-S Forming Presses are shown here. Write for detailed information on these and other W-S hydraulic presses for forming, forging, flanging, straightening, shearing, bending, piercing, nosing, assembling and other metal-working operations. The Watson-Stillman Company, Roselle, N. J.



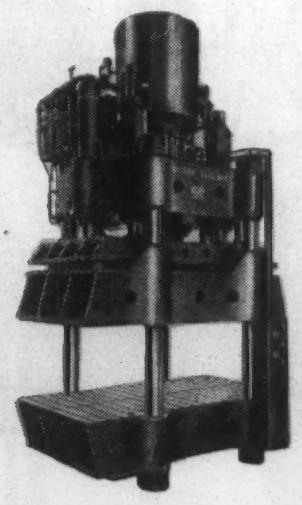
200-Ton Single Action Forming Press



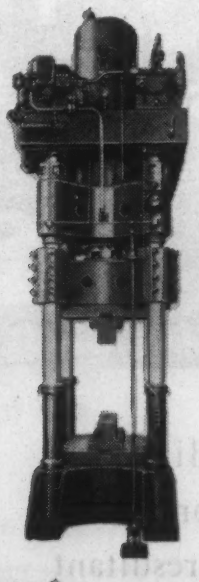
300-Ton Double Action Forming Press



75-Ton Utility Press

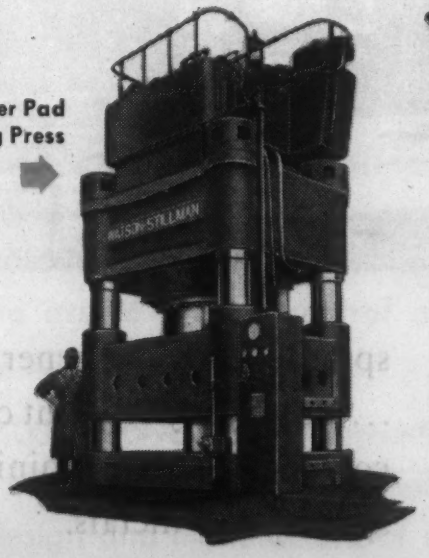


800-Ton Double Action Forming Press

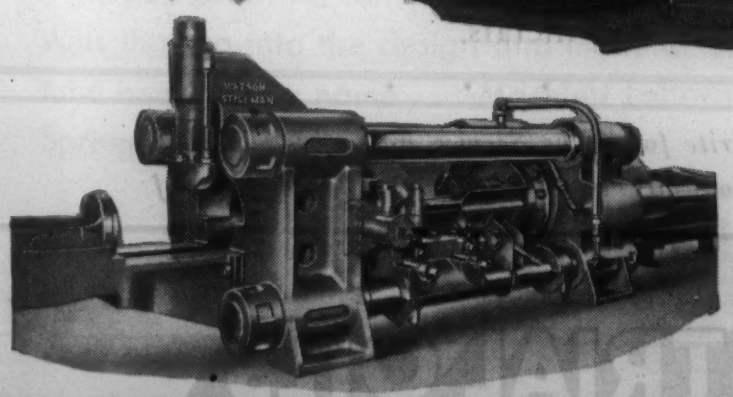


500-Ton Forging Press

4500-Ton Rubber Pad Forming Press



1000-Ton Extrusion Press



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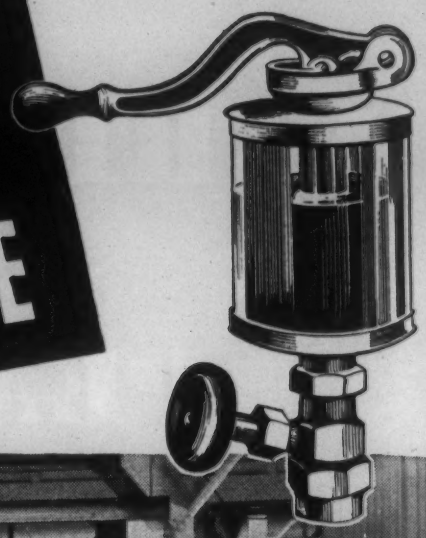
Designers and manufacturers of Hydraulic Equipment, Forged Steel Fittings and Valves.

6540

BETTER LUBRICATION *means* BETTER MAINTENANCE



IF you are experiencing difficult maintenance, better check lubrication. It may be inadequate with resultant excessive wear.

Sinclair offers better lubrication for better maintenance of MACHINING equipment with specialized hydraulic, spindle, gear and general purpose oils ... also highly efficient cutting oils and coolants for all machining operations, speeds, and metals.

• • •

(Write for "The Service Factor"— published periodically and devoted to the solution of lubricating problems.)

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FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

PRECISION AT 2,000,000 VOLTS

ANOTHER MACHLETT TECHNIQUE

WE ARE not going to tell you here why this tube was made, what it does, or what it is for. The important thing about it to you as a user of industrial X-ray tubes, and of oscillators for induction heating, is that it represents the toughest assignment ever handed the electronic tube industry, and that of all tube makers only Machlett perfected the techniques that made the tube possible.

The tube is sealed-off, vacuum-tight, and operates at 2,000,000 volts, direct current. These and other difficult conditions were essential to assure high and constant power, reduction of heat, and precise focusing of the electron beam.

Electrical and mechanical problems presented by the tube were so severe that some scientists doubted they could be solved, but Machlett, drawing upon its long experience, met every requirement in a little over two years.

This is significant to you because every electronic tube, whether it produces X-rays, or radio waves, or is a rectifier, depends for its success in your service upon correct design, proper vacuum, adequate insulation, and precision-made parts, to assure precise control of the electrons that make any such tube function.

The perfection of this 2,000,000-volt direct-current tube is the best proof we can offer of the value of the Machlett skills that go into the design and manufacture of every tube bearing our name . . . Machlett Laboratories, Inc., Springdale, Connecticut.

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TODAY THEIR LARGEST MAKER

HOW TO LOWER YOUR X-RAY FILM-PROCESSING COST

Drain off your old x-ray film processing solutions and fill up with Supermix Developer and Fixer.

Because of their long life, these liquid chemicals are economical to use, processing x-ray films at a lower cost per square inch.

Additional economy is achieved by revitalizing the Developer periodically with Refresher, thus making the Developer last up to four times longer.

Order economical Supermix film-processing chemicals today. Address your nearby G-E Branch Office.

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GENERAL ELECTRIC X-RAY CORPORATION

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CLIP THIS SCHEDULE OF ECONOMICAL DISCOUNT PRICES

	Developer	Refresher	Fixer
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per bottle	$1.00	$1.15	$1.00
per case of 12 bottles	.90	1.03	.90
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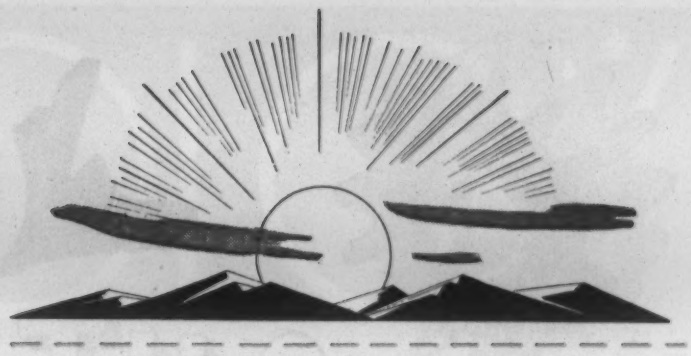
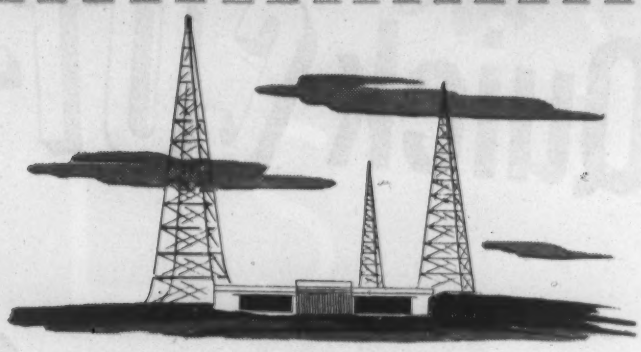
per bottle	2.75	----	2.70
per bottle in lots of 6 or more	2.47	----	2.43
On bottles to make 5 GALLONS			
per bottle	4.50	5.25	4.25
per bottle in lots of 4 or more	4.05	4.72	3.82

Prices f. o. b. U. S. Branches. Prices will be increased by the amount of such sales (or use) tax as may be applicable.

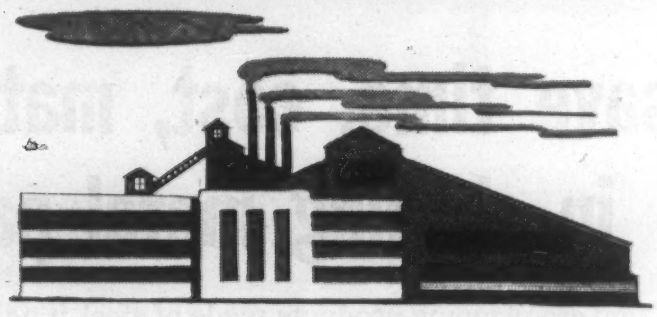
A Great Electronic Day...



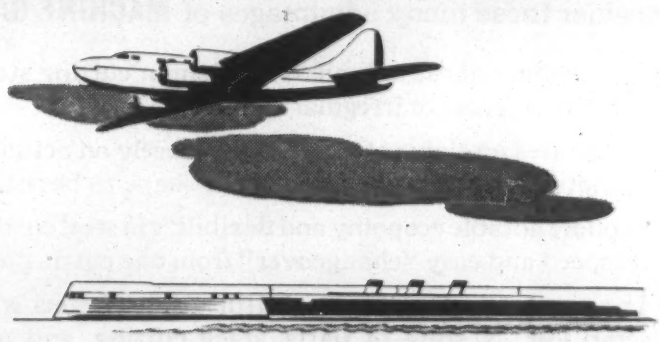
for Communications



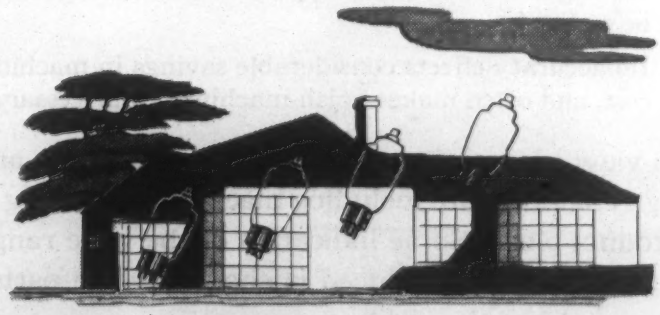
for Industry



for Transportation



for Home



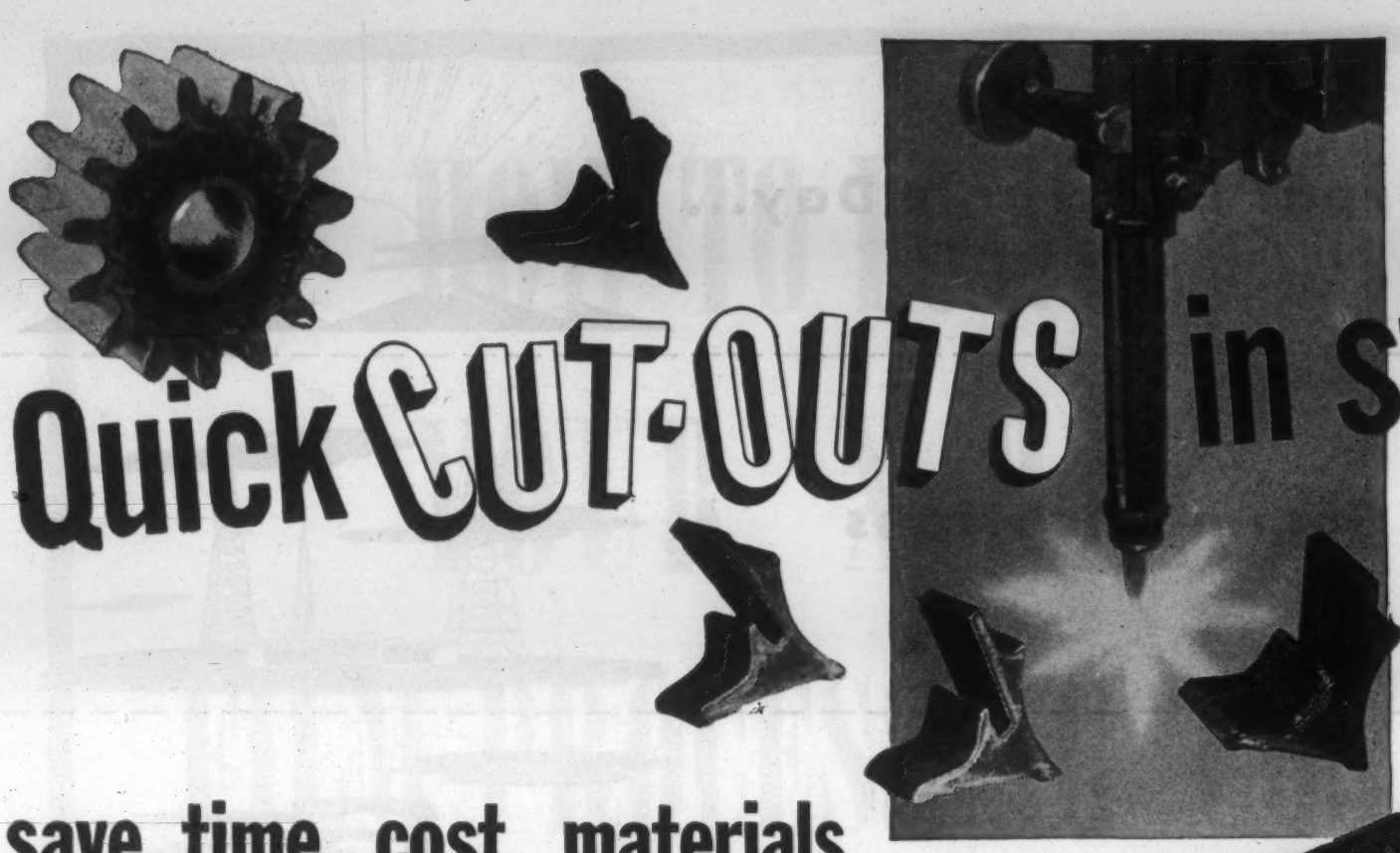
Raytheon is proud of its contributions in the development of new electronic tubes and complete electronic equipment for the Armed Forces. Proud of the trust the military has placed in our designs, engineering and manufacturing abilities.

When war ends, Raytheon's wartime experience, research facilities, engineering and the production skills of over 16,000 men and women will be turned to peacetime electronics. Then you'll hear about and see Raytheon Electronic Equipment that will provide untold benefits in all phases of electronics. In the coming Age of Electronics . . . LOOK to Raytheon for complete electronic equipment and electronic tubes.

Tune in the Raytheon radio program: "MEET YOUR NAVY," every Saturday night on the entire Blue Network. Consult your local newspaper for time and station.

RAYTHEON
MANUFACTURING COMPANY
Newton and Waltham, Massachusetts

Devoted to research and manufacture of complete electronic equipment; receiving, transmitting and hearing aid tubes; transformers; and voltage stabilizers.



Quick CUT-OUTS in steel

save time, cost, materials in shaping metal parts

If you are planning products made of steel, it will pay you to consider these many advantages of **MACHINE GAS CUTTING:**

- It provides almost unlimited freedom in cutting steel of any section into regular or irregular shapes.
- It requires no elaborate patterns—merely an actual-size tracing, or metal or wooden template of the shape to be cut.
- It offers notable economy and flexibility in steel cutting because of its speed and easy "changeover" from one cutting job to another.
- It permits most economical utilization of steel with minimum scrap loss. Nesting of parts, stack cutting, and multiple-torch cutting are some of the ways in which its fullest economy may be realized.
- Its accuracy effects considerable savings in machining time and cost, and often makes finish-machining unnecessary.

In view of these important advantages, more and more design engineers are including machine gas cutting in their new product plans. Some indication of the wide range of shapes currently being produced is shown by the parts illustrated above and at the right.

If you want further details on the scope of machine gas cutting and the many new design freedoms it offers, representatives of Air Reduction's Field Engineering Division will supply full information. Write to Dept. MA, New York office, for further information.

BUY UNITED STATES WAR BONDS

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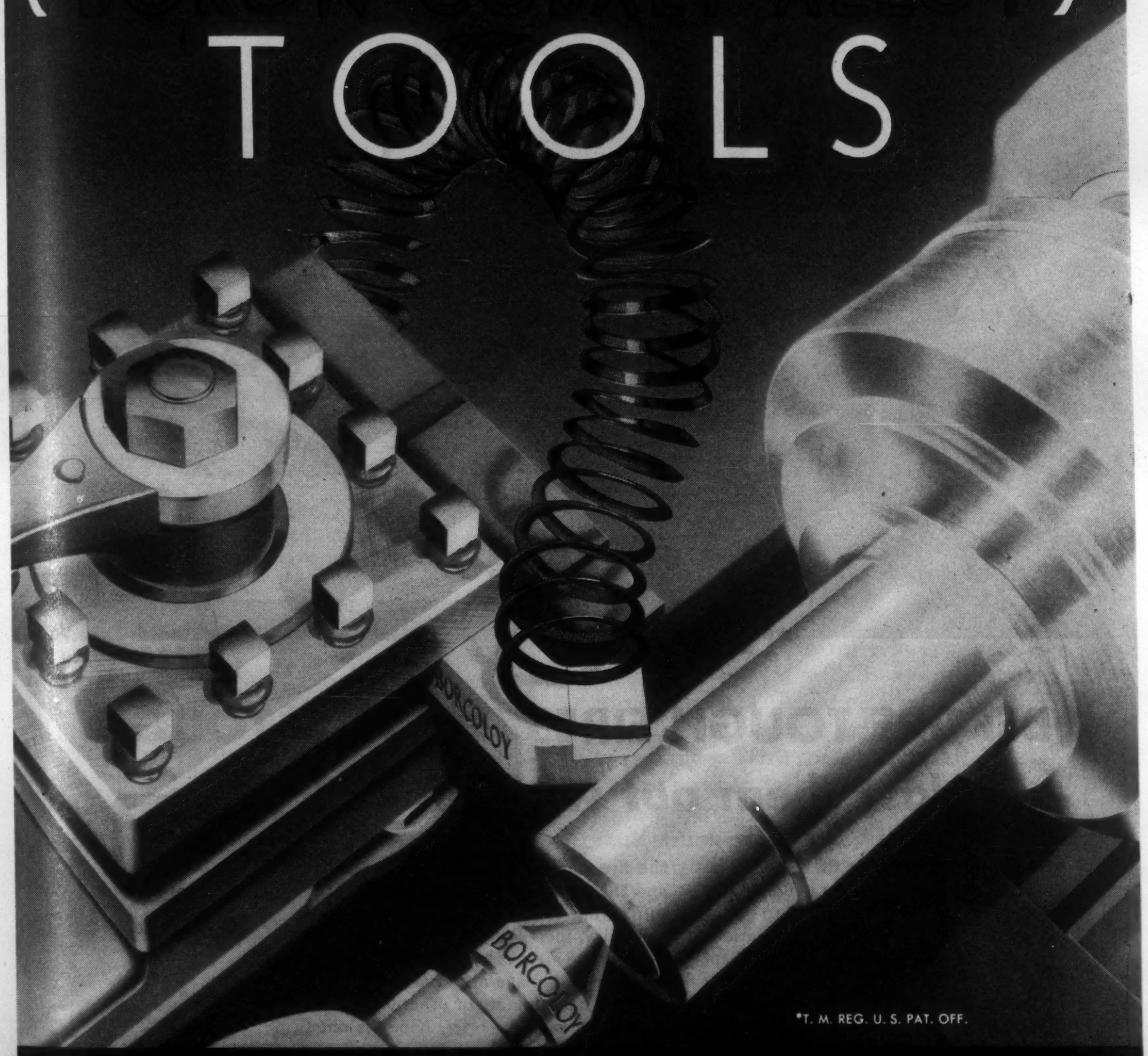
Offices in all Principal Cities

BORCOLOY*

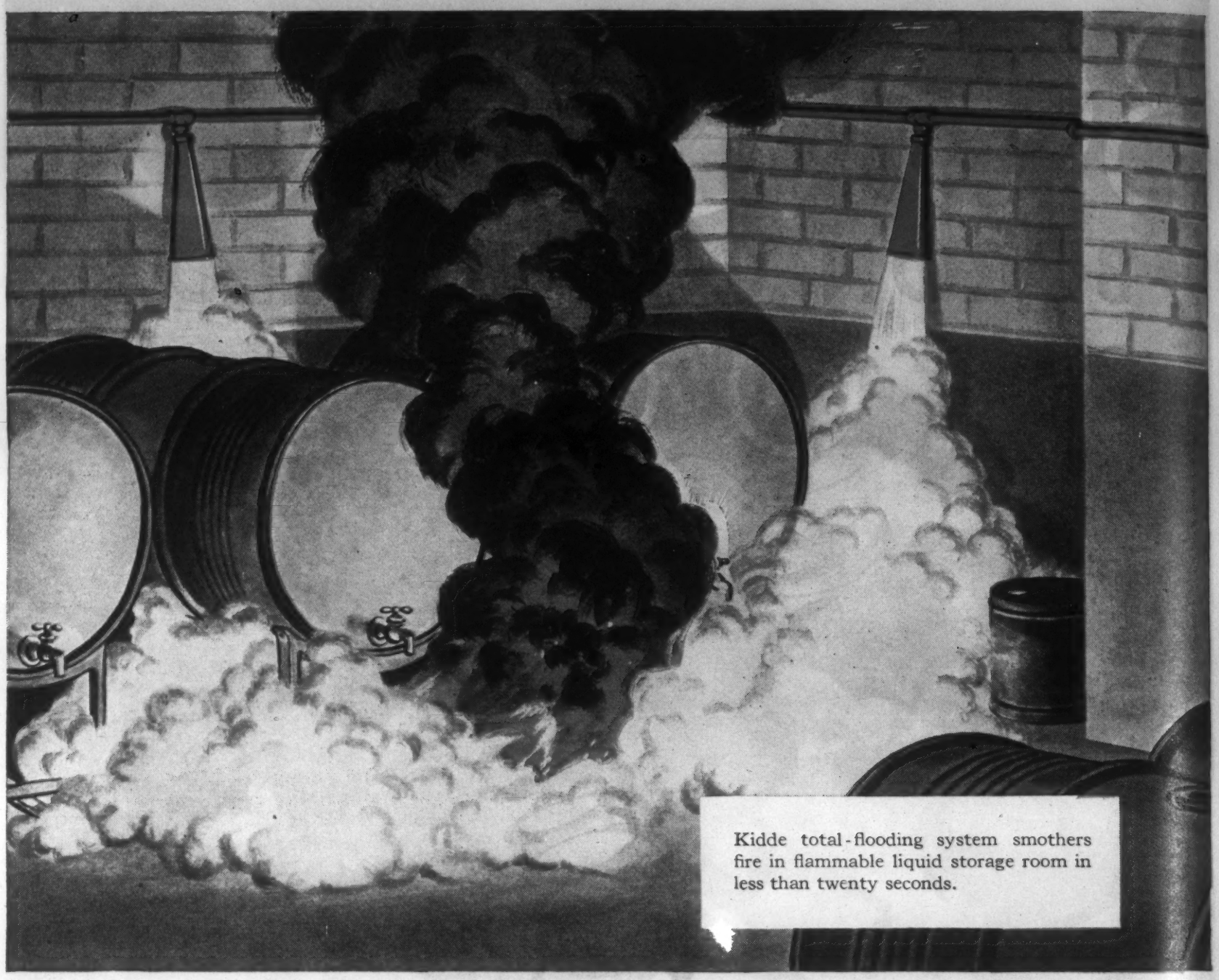
(BORON-COBALT ALLOY)

TOOLS



*T. M. REG. U. S. PAT. OFF.

A NEW, SUPER HIGH-SPEED, TOOL STEEL WITH, (1) ALL THE DISTINCTIVE FEATURES OF "CENTRIFUGALLY CAST" ALLOYS, (2) HIGH WEAR RESISTANCE DUE TO THE PRESENCE OF BORON AND (3) A MAXIMUM RED HARDNESS IMPARTED BY TWENTY PERCENT COBALT



BEFORE TOUGH FIRES GET TOO TOUGH

. . . blast them out with Kidde!

KIDDE KILLS TOUGH FIRES

In fighting the tough fires—the fast-moving ones that break out in flammable liquids (class B); and the hard-to-get-at types that start in electrical installations (class C)—you've got to smother them fast or they'll spread beyond control in a few minutes.

Ordinary water-type extinguishers can't control these tough fires. But built-in Kidde systems, employing carbon dioxide, will smother them in a matter of seconds. That is why Underwriters' and Factory Mutual Laboratories approve Kidde for fighting *both* these types of fire.

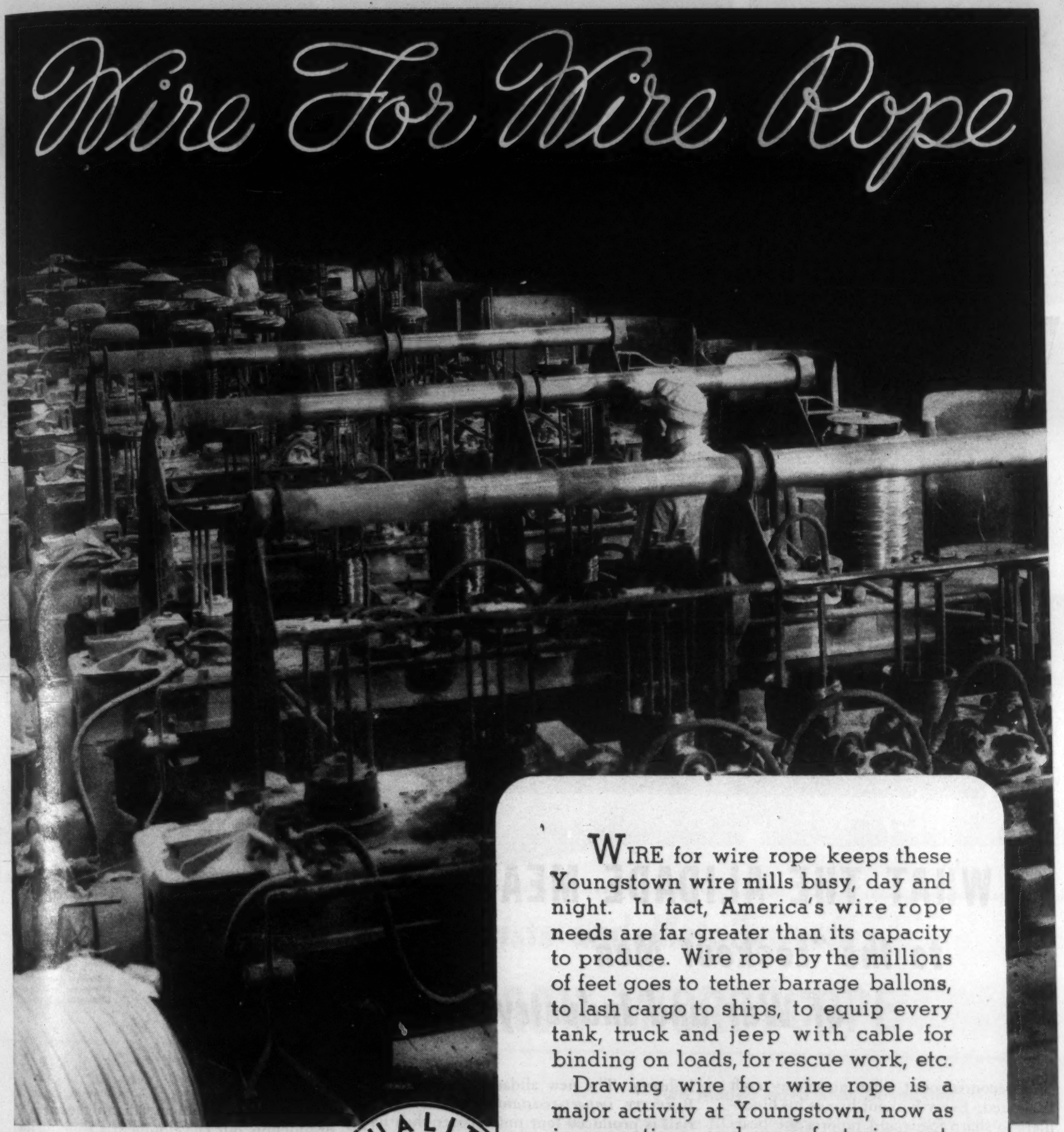
Some of the Kidde built-in systems are so designed that the fire can be automatically isolated, and the room quickly filled with flame-suffocating carbon dioxide. This gas—being dry, inert, odorless and non-toxic—leaves no after-fire mess to be cleaned up, cannot damage any materials; and does not contaminate or otherwise spoil costly processes. In brief, Kidde is one of the speediest, cleanest and most effective fire extinguishers in use today.

So, check this list (at right) now. Does even *one* of these hazards exist in your plant? If it does, write Kidde today. Ask to have a Kidde representative call upon you. He'll be glad to share his fire-prevention know-how with you.

Process Rooms
Ovens
Spreaders
Motors
Storage Rooms
Mixers
Coaters
Transformers
Dip Tanks
Agitators
Washers
Quench Tanks

Walter Kidde & Company, Inc. • 140 Cedar Street • New York 6, N. Y.

Wire For Wire Rope



WIRE for wire rope keeps these Youngstown wire mills busy, day and night. In fact, America's wire rope needs are far greater than its capacity to produce. Wire rope by the millions of feet goes to tether barrage ballons, to lash cargo to ships, to equip every tank, truck and jeep with cable for binding on loads, for rescue work, etc.

Drawing wire for wire rope is a major activity at Youngstown, now as in peacetime, and manufacturing output is geared to the maximum of our ability to produce, yet quality supersedes volume with manufacturing standards maintained at the most exacting levels. Ready now to talk to you about your wire needs, present and future, we are equipped to meet your requirements, whether they call for standard or special specifications on chemical and metallurgical characteristics and physical tolerances.

Pipe and Tubular Products - Sheets - Plates - Conduit - Bars - Electrolytic Tin Plate - Coke Tin Plate - Rods - Wire - Nails - Tie Plates and Spikes - Alloy and Yoloy Steels.

QUALITY TRADE MARK YOUNGSTOWN SERVICE

YOUNGSTOWN

THE YOUNGSTOWN SHEET AND TUBE COMPANY

YOUNGSTOWN, OHIO

Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

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TRADE-MARK

PRODUCTION COSTS	*Cut 50 per cent*
PRODUCTION RATE	*4 Times Faster*
IMPACT STRENGTH	*Much Greater*
FINISH	*Non-Corrodible*

Produced by Daystrom Corporation.
Molded Parts by Northern Industrial Chemical Company.

WHAT THE ALIDADE MEANS
to the "Lookout Men" of War and Industry

Split seconds count when an enemy craft is sighted. Every lookout brings his binoculars to sharp focus and reports the bearing shown on his Mark V Surface Lookout Alidade. From these readings, fire control can compute the range, whereupon our ships' guns swing for action.

Alidades were formerly machined by skilled labor from then critical metal, but the time came when their production had to be vastly stepped up. The Navy turned to BAKELITE plastics—with results that point the way to product improvement and production economy for the "lookout men" of industry. The new alidade, molded from BAKELITE *impact-resistant* phenolic materials is produced four times faster than its predecessor—costs are reduced 50 per cent—corrosion is wholly eliminated.

The success of the alidade was assured because designers, fabricators, and Bakelite Plastics Headquarters worked together as a co-ordinated team. Similarly, your products can benefit from the same teamwork, and from the employment of a BAKELITE plastic material with the exact properties to meet your individual requirements.

If you have a problem affecting essential production, our Development Laboratories and technical representatives will be glad to work with you. If you are planning for the future, write for Booklet 49M.

TRADE MARK

BAKELITE CORPORATION
Unit of Union Carbide and Carbon Corporation
30 EAST 42ND STREET . NEW YORK 17, N. Y.

UCC

PLASTICS

At Work for Chemists and Metallurgists

...the RCA ELECTRON MICROSCOPE

PROMINENTLY featured in some of the most interesting papers presented this year have been slides made from micrographs taken with the RCA Electron Microscope.

Advances in the technique of preparing surface replicas for study with this instrument have opened the way to important metallurgical disclosures.

In process industries discoveries made have led to substantial improvements in product quality and process control.

Extreme resolving power and depth of focus are characteristic of the RCA Electron Microscope. These, together with its great range of magnification, are shown in the micrographs here reproduced.

Two Models Have Been Developed

Two models of the RCA Electron Microscope have been developed: one, a large "Universal" Model (Type EMU); the other, a smaller, lower-priced "Console" Model (Type EMC). Descriptions and specifications of both, with many interesting illustrations, are contained in a new RCA Bulletin now ready. Write for your copy. Address Department 205.

1919
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RCA

25 Years of Progress
In Radio
and Electronics

RADIO CORPORATION OF AMERICA

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PERMANENT MAGNETS MAY DO IT BETTER

OFFICIAL U. S. NAVY PHOTOGRAPH

Battle Commands Reach All Hands!

ON a modern U. S. dreadnaught, about 2200 telephones and more than 300 loudspeakers link all battle stations. They flash orders and reports instantly—make possible the split-second timing that wins battles.

Vital parts of each telephone and speaker are permanent magnets. They are also employed in radio and sub-detection equipment, firing systems, compasses, instruments and numerous other devices, raising the total per battleship high into the thousands.

Because we manufacture permanent magnets for virtually every use known to science, our specialized knowledge of design and production is unusually complete. If you have a problem involving permanent magnets, our engineers will be pleased to consult with you. Write for a copy of our "Permanent Magnet Manual".

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The

INDIANA STEEL PRODUCTS

Company

★ SPECIALISTS IN PERMANENT MAGNETS SINCE 1910 ★

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Jap Flat-Top Meets Its Doom

BY JAMES M. SESSIONS

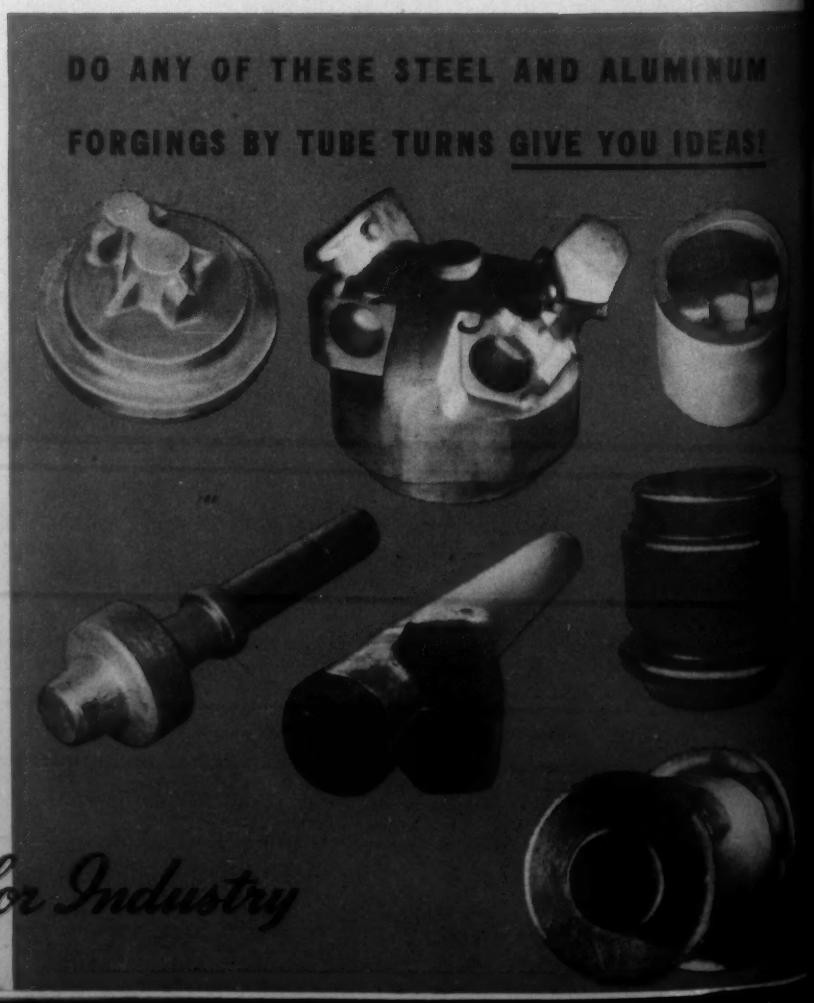
NO. 12 OF A SERIES "HIGHLIGHTS OF WORLD WAR II" PRESENTED BY TUBE TURNS (INC.) LOUISVILLE, KY. SEE OTHER SIDE

"I'M GETTING TUBE TURNS' OPINION ON ITS FORGE-ABILITY"

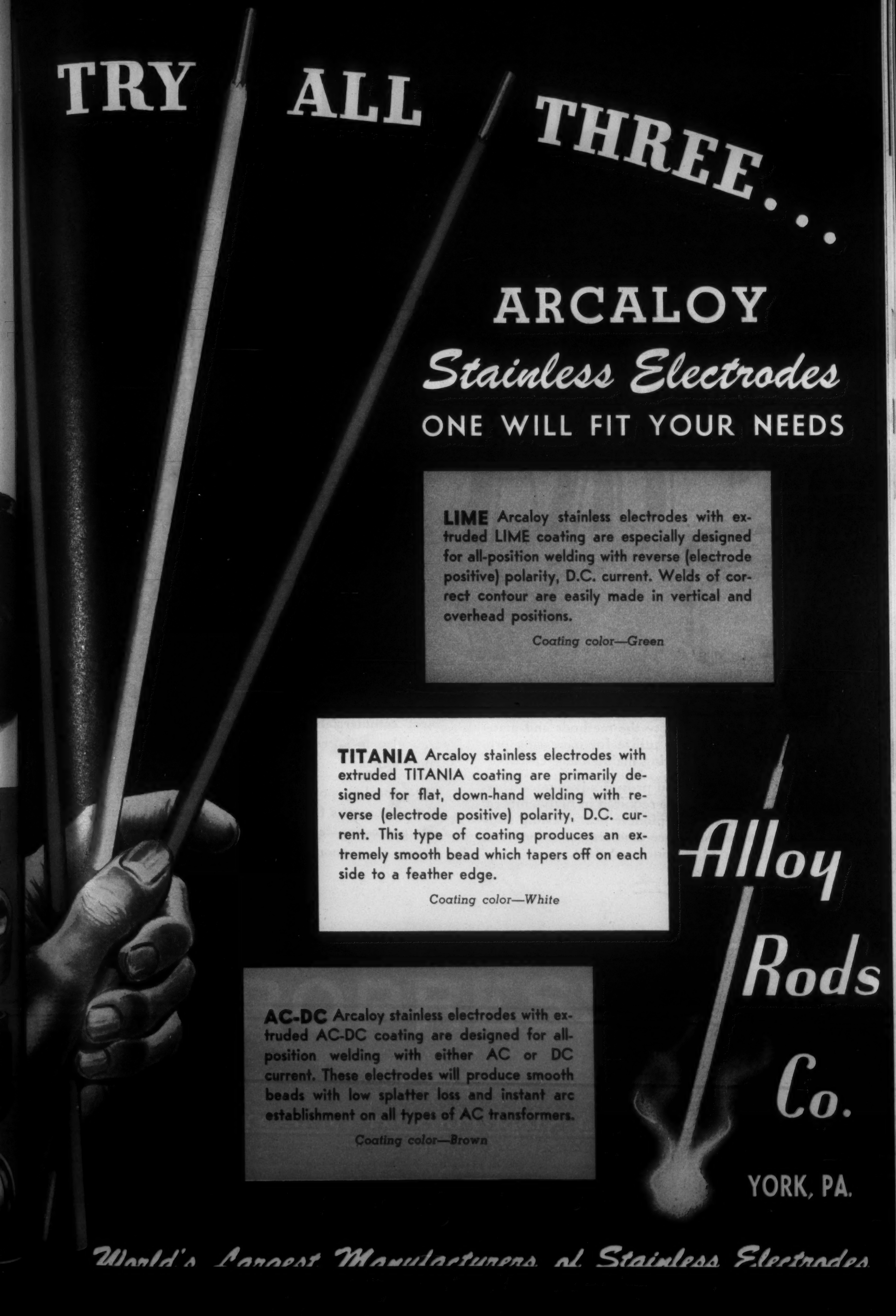
Perhaps *you* have a part or product that forging would improve . . . or a present forging job that could be bettered in precision, cost or service.

We welcome opportunities to tackle difficult upset or press forgings, in either steel or light metals. At Tube Turns you'll find a stimulating kind of cooperation — in which practical forging skill and engineering knowledge are accented by resourceful thinking and original techniques. You'll find laboratories that offer virtually every modern method for mechanical, chemical and electrical research and testing. You'll find ample production facilities for volume output plus exacting accuracy — upsetters and presses in sizes up to the largest, heat treating furnaces of the most recent types and one of the largest die shops in the country.

That's why you often hear it said, "I'm getting Tube Turns' opinion" . . . and its sequel, "We're giving Tube Turns the job."—TUBE TURNS (Inc.), Louisville 1, Ky.

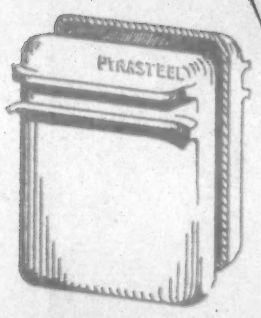


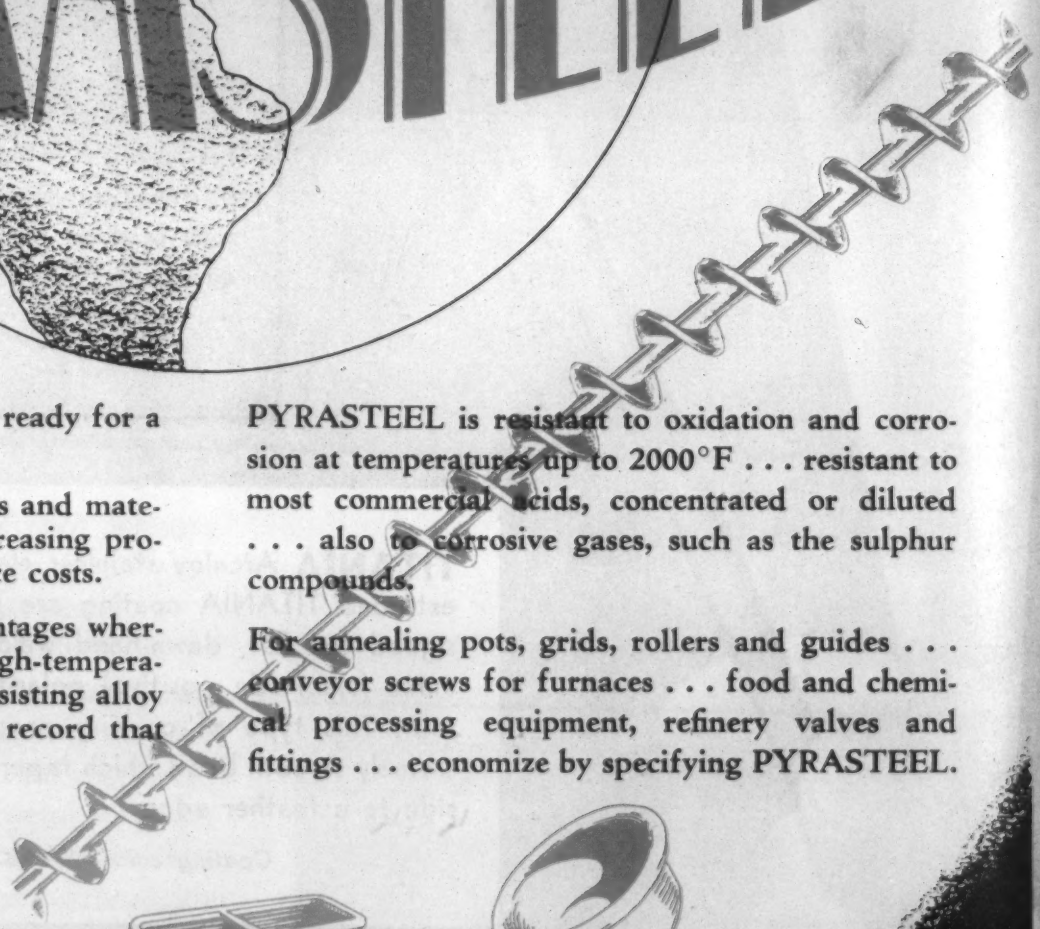
TUBE TURNS *Forgings for Industry*


TRY ALL THREE...
ARCALOY
Stainless Electrodes
ONE WILL FIT YOUR NEEDS
LIME Arcaloy stainless electrodes with extruded LIME coating are especially designed for all-position welding with reverse (electrode positive) polarity, D.C. current. Welds of correct contour are easily made in vertical and overhead positions.
Coating color—Green
TITANIA Arcaloy stainless electrodes with extruded TITANIA coating are primarily designed for flat, down-hand welding with reverse (electrode positive) polarity, D.C. current. This type of coating produces an extremely smooth bead which tapers off on each side to a feather edge.
Coating color—White
AC-DC Arcaloy stainless electrodes with extruded AC-DC coating are designed for all-position welding with either AC or DC current. These electrodes will produce smooth beads with low splatter loss and instant arc establishment on all types of AC transformers.
Coating color—Brown
Alloy Rods Co.
YORK, PA.
World's Largest Manufacturers of Stainless Electrodes

PLAN YOUR PRODUCTION

WITH PYRASTEEL





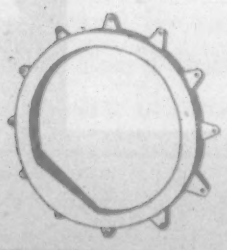
Out of this war will come a free world ready for a new era of industrial expansion.

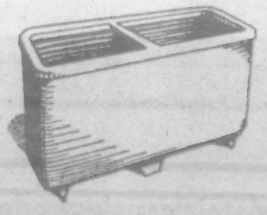
Now is the time to choose the methods and materials that you intend to utilize for increasing production rates and reducing maintenance costs.

PYRASTEEL offers you proved advantages wherever equipment parts are required in high-temperature applications. This pioneer heat-resisting alloy has a war-time and peace-time service record that may be duplicated in your own plant.

PYRASTEEL is resistant to oxidation and corrosion at temperatures up to 2000°F . . . resistant to most commercial acids, concentrated or diluted . . . also to corrosive gases, such as the sulphur compounds.

For annealing pots, grids, rollers and guides . . . conveyor screws for furnaces . . . food and chemical processing equipment, refinery valves and fittings . . . economize by specifying PYRASTEEL.





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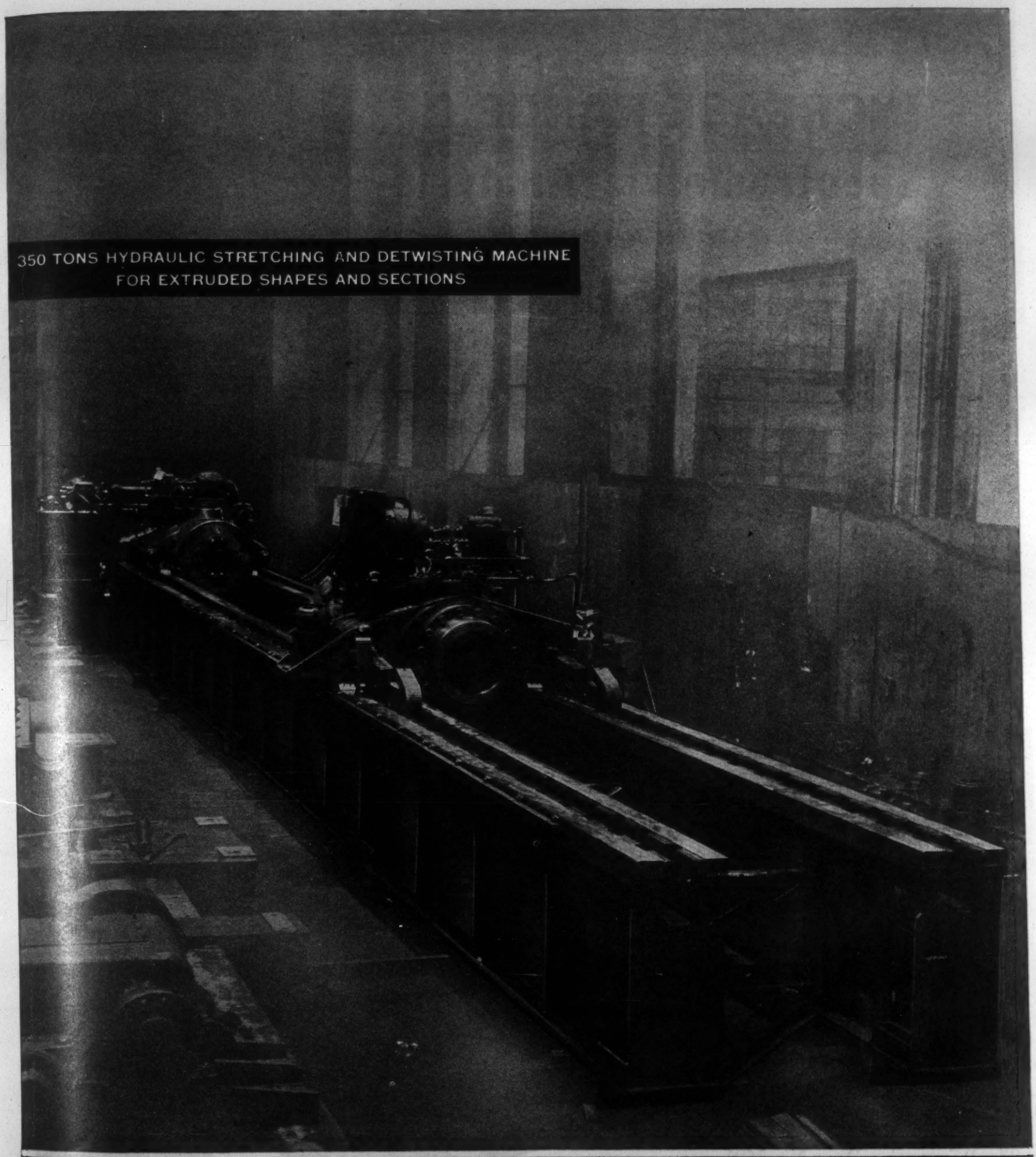
CHICAGO

Makers of Alloy Steel for 30 Years

PYRASTEEL for high temperatures

EVANSTEEL for strength



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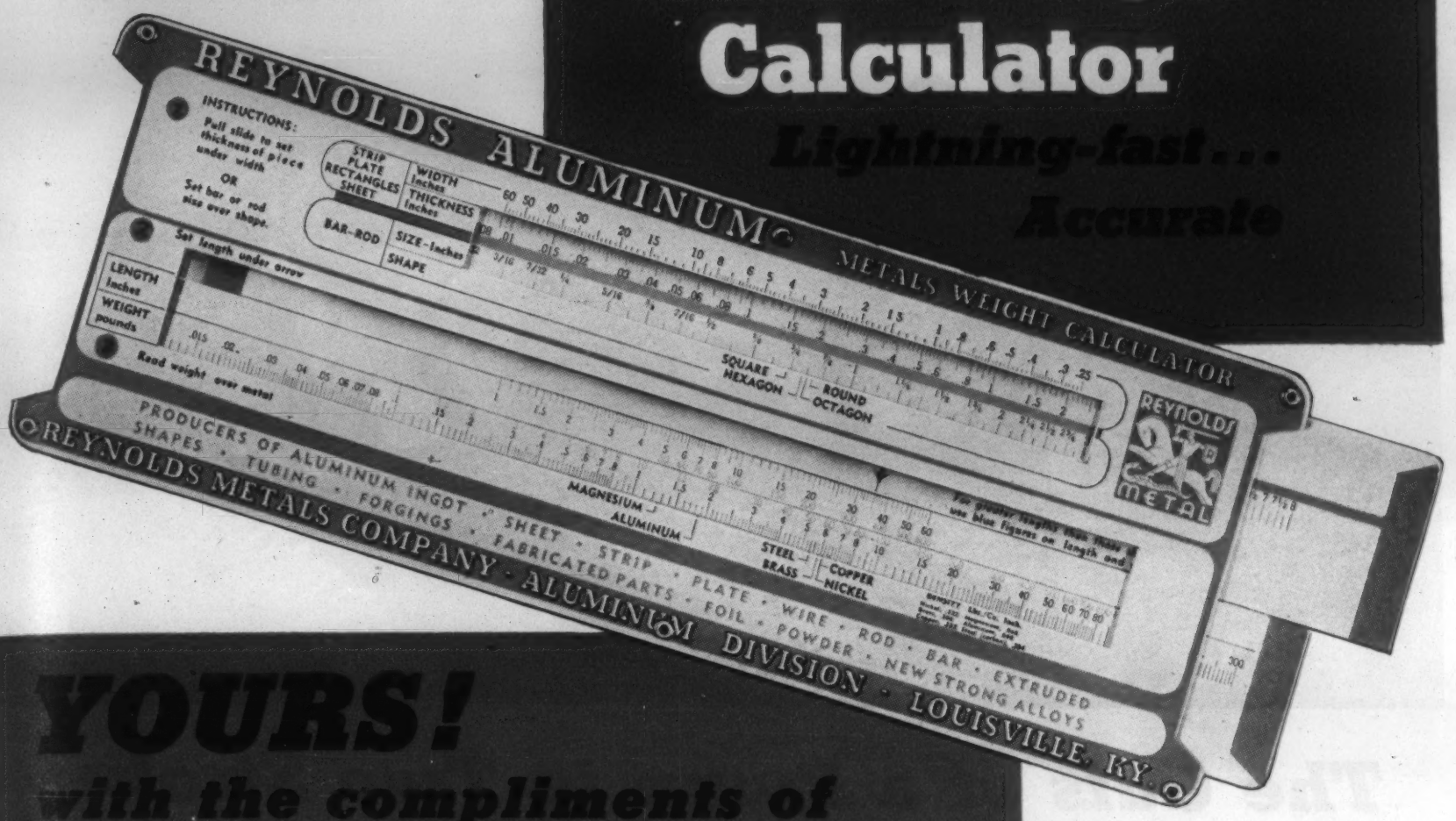
Metals Weight Calculator

Lightning-fast . . . Accurate



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with the compliments of

REYNOLDS ALUMINUM

A REAL TIME-SAVER. Engineers report that, besides facilitating absolute accuracy, the Reynolds Metals Weight Calculator saves up to 90% of the time ordinarily required to consult tables and make calculations.

Here is one of the handiest calculating devices ever developed.

All the answers INSTANTLY. Everyone who works with metals will find this instrument invaluable.

It does the work for you, saves up to 90% of the time and effort on weight calculation. Just make the settings—then read the results. Serves equally well with aluminum, steel, brass, copper, magnesium, and nickel.

The Reynolds *Metals Weight Calculator* is a convenient, durable, vestpocket-sized instrument, measuring only 3"x 8¾". With a flip of the finger, weights are calculated from cross-sectional dimensions and length as accurately as from published tables of theoretical weights. It can also be used to determine lengths from cross-sectional dimensions and weights.

Scales included are sheet, strip and plate; round wire and rod; square, hexagonal, octagonal and rectangular bar; tubing; and sheet circles. Range of instrument—from .0006 lbs. to 3000 lbs. —from an infinitesimal-sized piece of metal to a giant bar.

If you work with metals, you will find this Reynolds *Metals Weight Calculator* very helpful. Mailed post-free upon request, in a protective wrapping.

OUR SUPPLY IS LIMITED; SO PLEASE FILL IN AND

MAIL TODAY

REYNOLDS METALS COMPANY
Aluminum Division
2505 South Third Street
Louisville, Kentucky

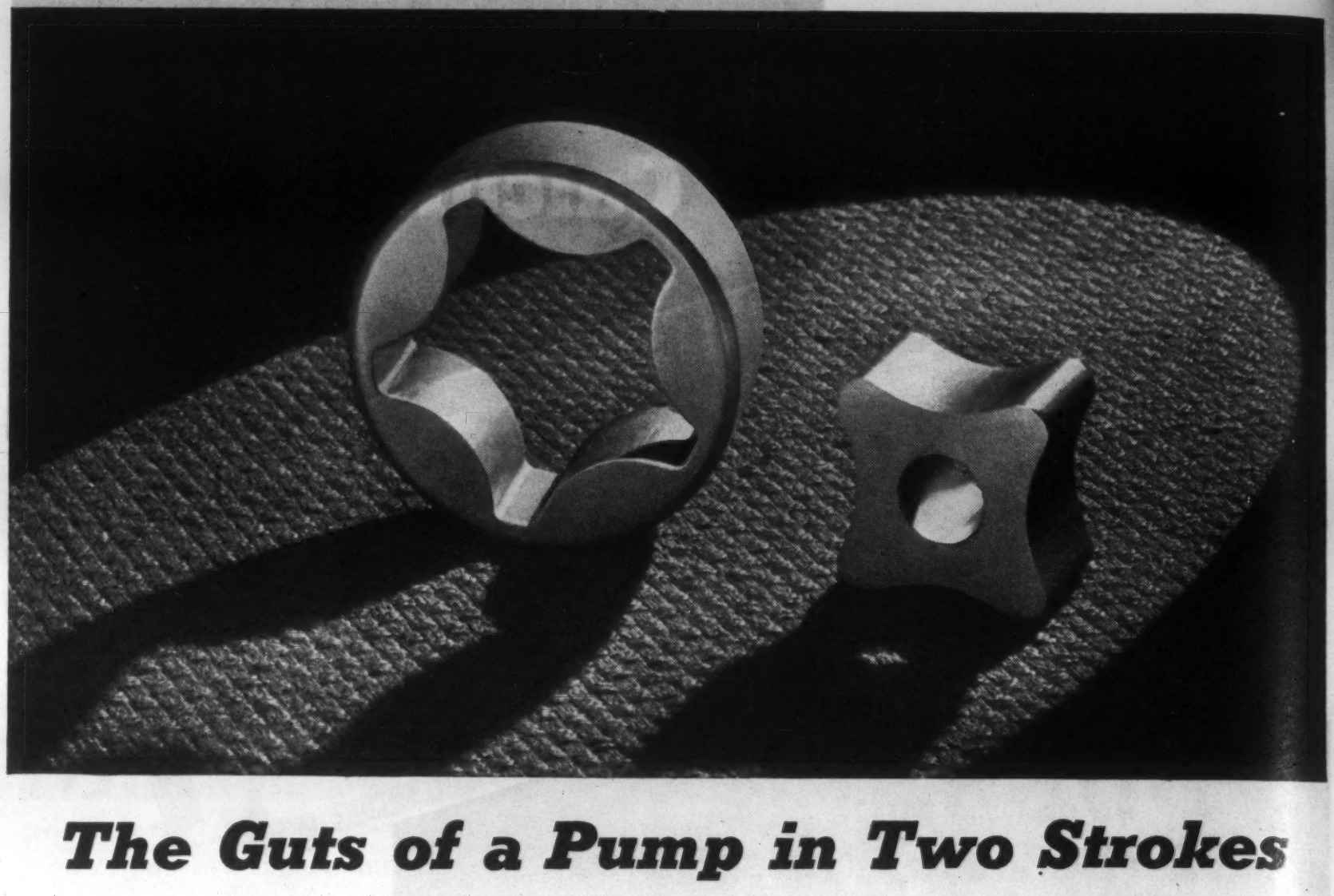
Please send me, without charge, a Reynolds *Metals Weight Calculator*.

Name_____ Title_____

Company_____

Street_____

City_____ Zone_____ State_____



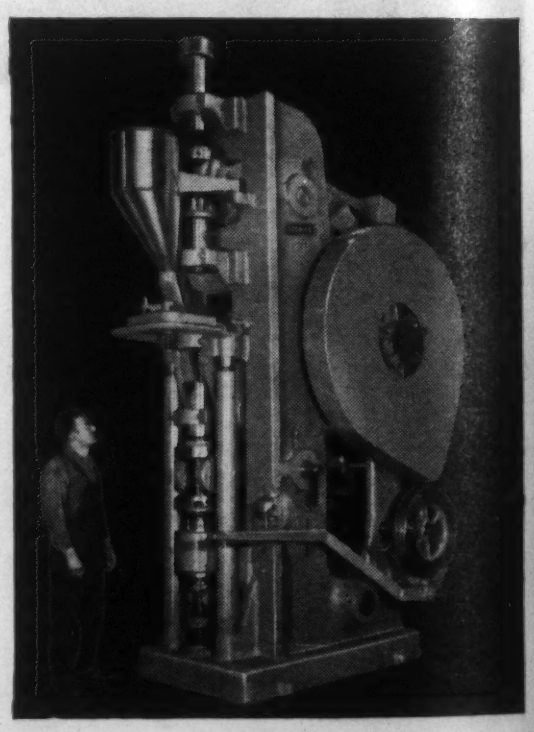
The Guts of a Pump in Two Strokes of a Press . . . with precision that couldn't be matched at many times the cost

Too difficult for one of the best tool shops in this country to machine—this Oilite Pump Gear set is being produced from powdered metals, automatically, at a high production rate and with unskilled labor on Stokes Tabletting Machines.

Stokes Presses are producing a great many intricate parts such as the above . . . large quantities of parts for gun mechanisms and other war purposes . . . 90% of the porous bearings made in this country today. Production rates are high . . . often hundreds per minute, depending on size, material, etc. Material waste is practically eliminated. Skilled operating labor is unnecessary. Parts produced are closely uniform, both in dimensions and physical characteristics. Set-up time for a job is usually a matter of weeks instead of months. Numerous other time, labor and money savings are obtained.

Stokes presses are the result of 25 years' pioneering and experience in the field of powder metallurgy . . . are rugged, built for this specific purpose . . . in many instances are operating, continuously, at overloads up to 70% with negligible deflection, and still producing highly accurate parts.

We invite inquiries and our laboratory facilities are available for experimental work.



Model "P-2" Powdered Metals Compressing Machine. Pressure applied from both above and below for uniform density. Maximum tablet size, 4" dia. Maximum die fill, 8". Pressure, 80 tons.

F. J. STOKES MACHINE COMPANY
5972 Tabor Road Philadelphia 20, Pa.

F.J.Stokes AUTOMATIC TABLETTING EQUIPMENT FJS Est. 1895

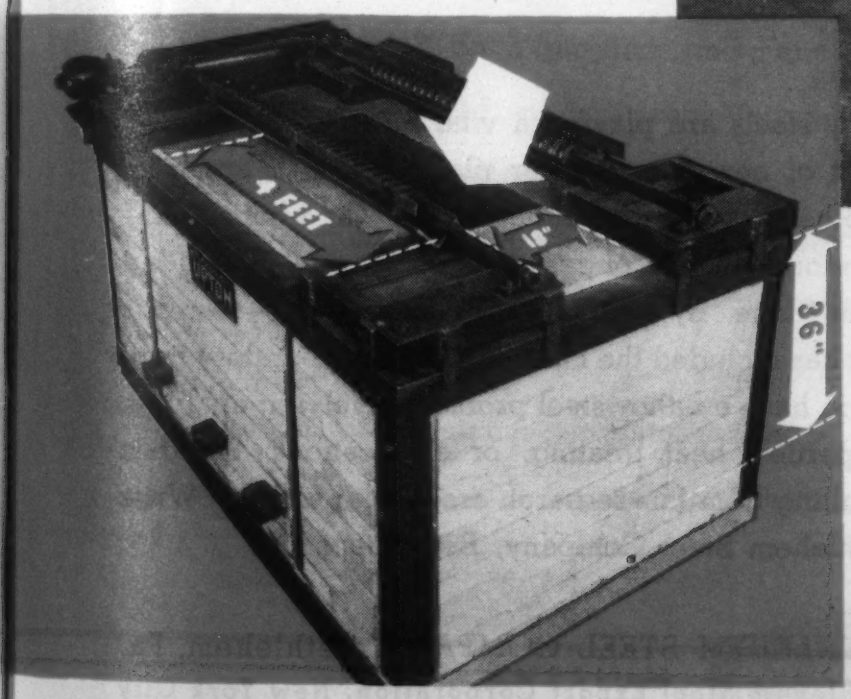
Upton ELECTRIC SALT BATH FURNACES

in ANY size ANY capacity

FOR ALL KINDS OF HEAT TREATING

The Sealed Electrode method of heating has tossed out all restrictions on salt bath furnace sizes and capacities! Upton Electric Salt Bath Furnaces can be built to any size you need—to any depth.

Upton Furnaces eliminate decarburization, reduce distortion, improve quality of finished work, require less skilled help to operate. RESULTS FROM UPTON ELECTRIC SALT BATH FURNACES ARE FOOLPROOF and COMPLETELY PREDICTABLE.



These furnaces nearing completion, indicate some of the sizes that are available in Upton Electric Salt Bath Furnaces. The long (21′-0″) furnace in the foreground is for continuous anneal of brass cartridge cases. The other vertical furnaces are for High Speed and Moly Steel hardening. Other sizes are as readily available.

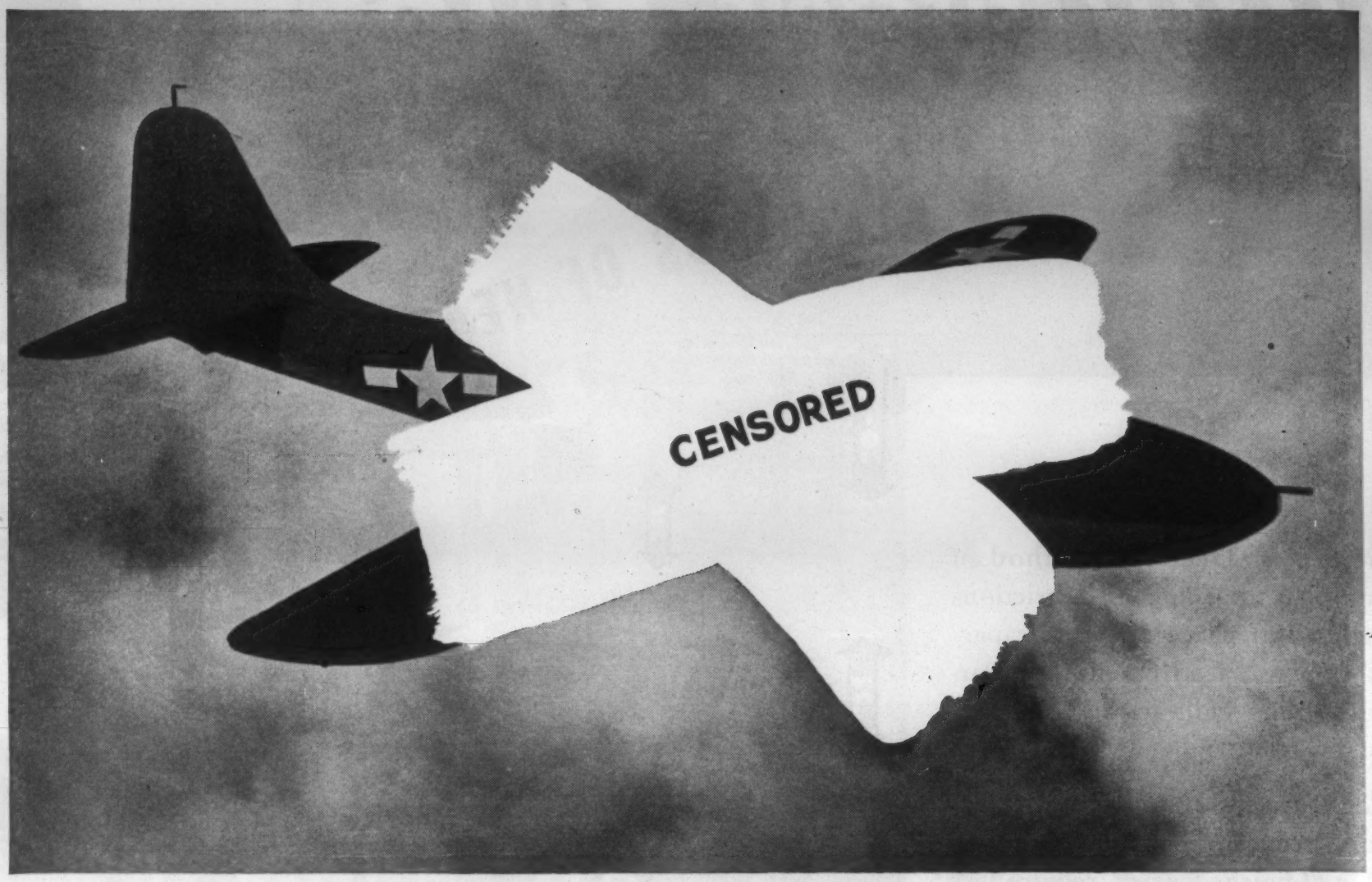
Ask for complete information now; Please mention the type of work to be heat treated.

Upton ELECTRIC FURNACE DIV.

COMMERCE PATTERN FOUNDRY AND MACHINE COMPANY

7425 MELVILLE AT GREEN

DETROIT 17, MICHIGAN



THE *Rocket Plane* TAKES TO THE SKIES

For years designers of high-speed aircraft have dreamed of the day when planes would shed their "props" and be driven, instead, by jet propulsion.

Today, at Bell Aircraft, the rocket plane is no longer a dream but a reality. It has emerged from the drawing-board stage and is now in production. A plane that flies at such speeds and altitudes, and with such startling maneuverability, that its test flights caused engineers to say that the jet plane had opened a new chapter in aviation history.

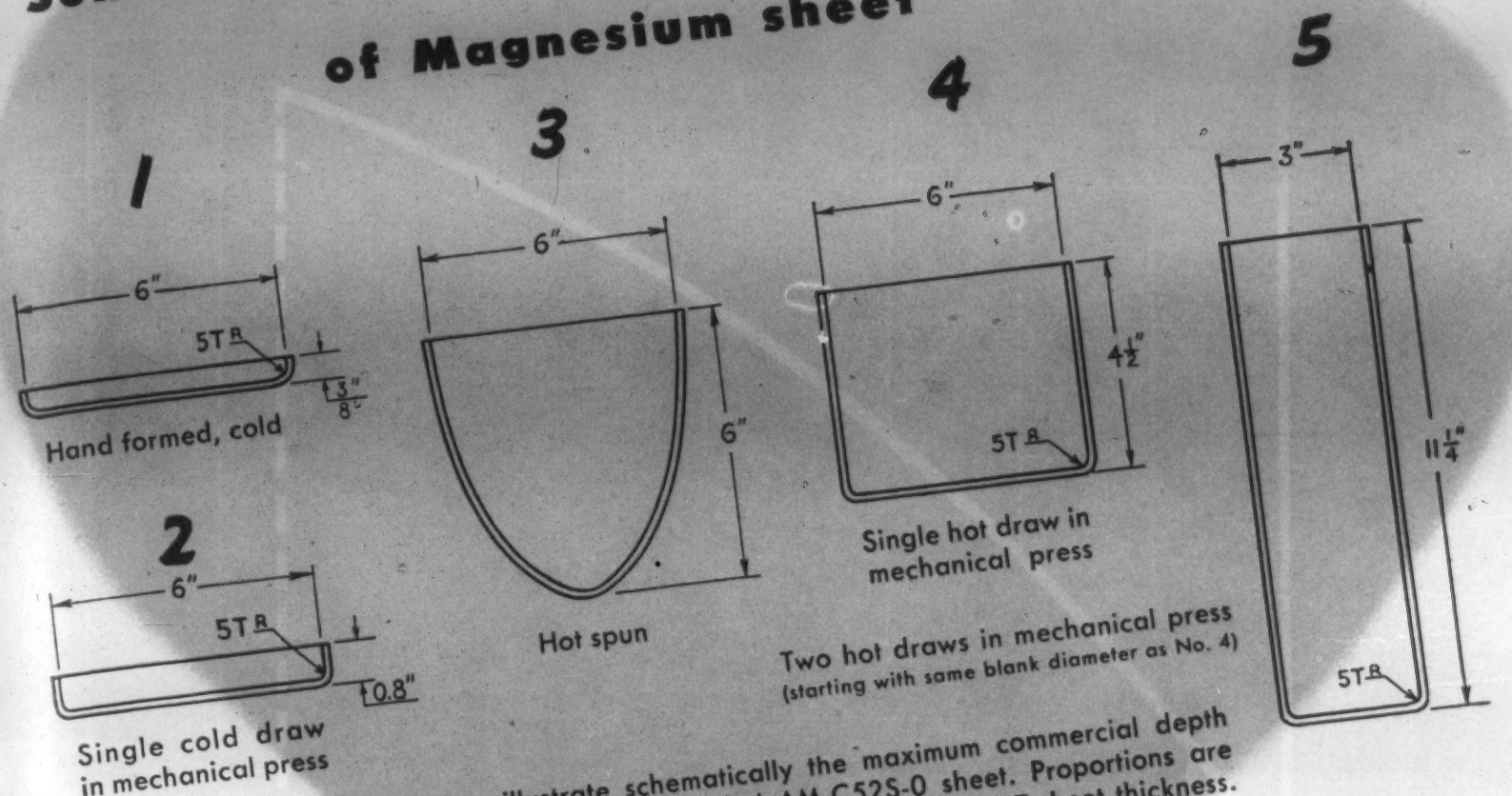
Mechanical features of Bell's new "rocket ship" are naturally shrouded in wartime secrecy. It can be said, however, that many of the parts made by Bell—and many of the parts supplied by other manufacturers—are of Bethlehem alloy steels. As a matter of fact, through the years of its growth to its present high position, the Bell organization has made Bethlehem Steel one of its chief sources of supply.

Alloy steels are playing a vital part in the development of newer and faster planes, and in hundreds of other products essential to the war effort. A tremendous amount of research on wartime steels has been done by Bethlehem metallurgists—research that has included the most exhaustive laboratory tests. If you have an alloy-steel problem involving analyses, properties, heat treating, or applications, the data resulting from this research are at your service. Write Bethlehem Steel Company, Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa.
Bethlehem Steel Export Corporation, New York City

★ ★ BETHLEHEM STEEL ★ ★

Some notes on the Formability of Magnesium sheet



The sketches illustrate schematically the maximum commercial depth of draw in working AM3S-0 and AM-C52S-0 sheet. Proportions are based on round cups formed from 0.064-inch sheet. T=sheet thickness.

"How deep will it draw?". . ."Can it be spun?". . ."Must the metal be heated to produce this shape?" Such questions, and many more, are answered in American Magnesium's book, "Designing with Magnesium".

Magnesium has been an extremely active war worker. There is the wealth of knowledge gained there to guide you, plus American Magnesium's more than twenty years of working with magnesium alloys.

Achieving the ultimate in lightness is a job which magnesium does well. It weighs only one-fourth as much as the heavy metals. It has a high strength-weight ratio. If you are interested in employing this weight-saving ability of magnesium, our engineers will gladly assist you. Write Aluminum Company of America, Sales Agent for American Magnesium Corporation Products, 1710 Gulf Building, Pittsburgh 19, Penna.

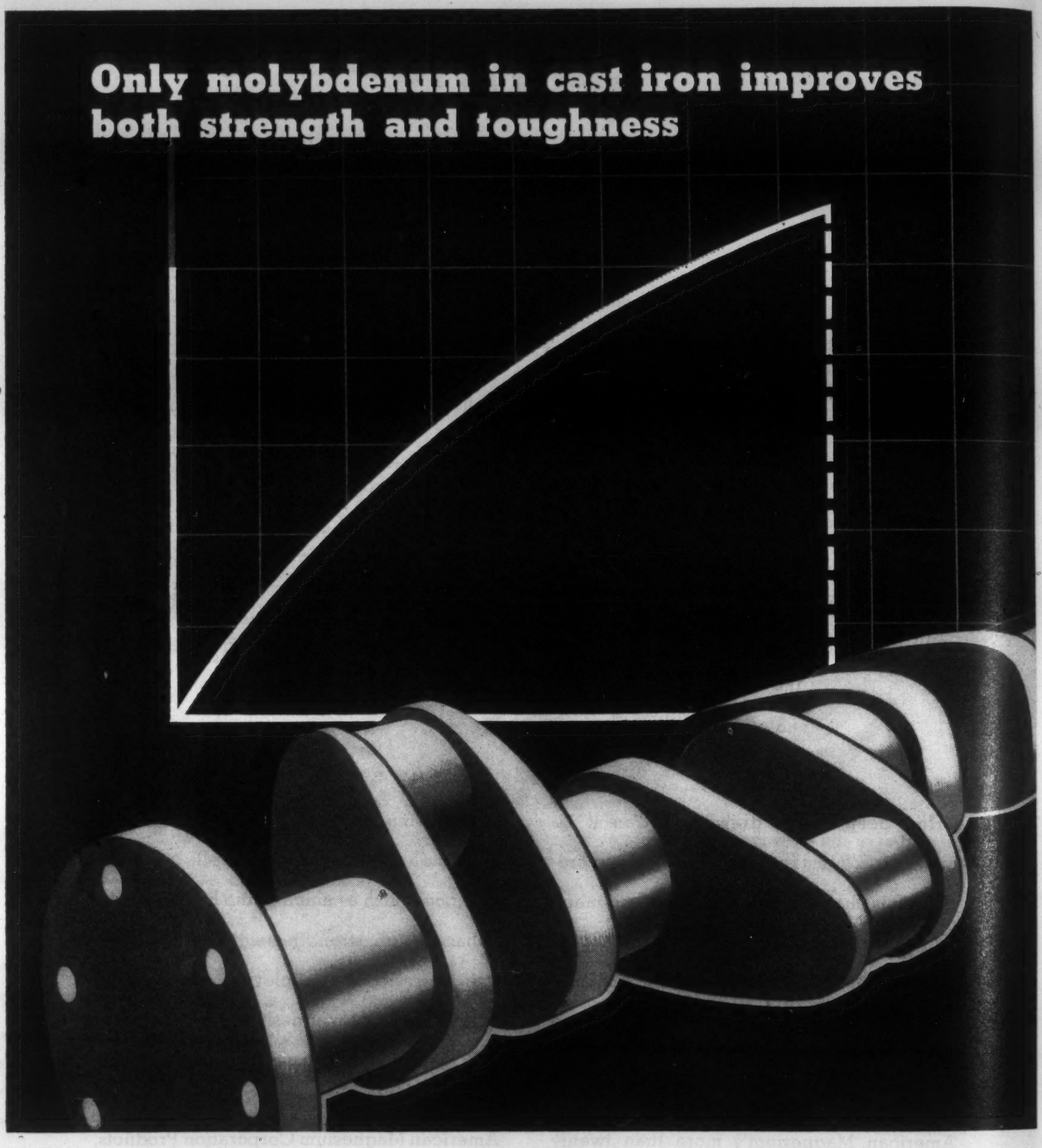
MAGNESIUM MAZLO PRODUCTS

REG. U.S. PAT. OFF.

AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

Only molybdenum in cast iron improves both strength and toughness



CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

MOLYBDIC OXIDE, BRIQUETTED OR CANNED • FERROMOLYBDENUM • "CALCIUM MOLYBDATE"

Climax Molybdenum Company

500 Fifth Avenue · New York City

MOLY

PRODUCTION *OK's* MILLIONS OF SMITHway ELECTRODES

SMITHway Electrodes in Action *on a B-29 Boeing Super Fortress. Saving 206 important pounds per landing gear at a time when it had to be done . . . stepping up design stress to over 100,000 lbs. per square inch . . . made possible with SMITHway Certified Electrodes and SMITHway welding technique.*

PRODUCTION puts its O. K. in a big way on SMITHway Certified Electrodes. Hundreds of millions of these "special analysis" electrodes — developed by and for the A. O. Smith Corporation, largest manufacturer of welded steel products — have welded hundreds of thousands of tons of the biggest, toughest steel jobs on record . . . proving they can produce more welds per man-hour at minimum cost.

No other electrodes offer such outstanding performance-proof. No other electrode manufacturer has such complete controls . . . including engineering research laboratory controls, plus complete quality-and-service controls of raw materials and processing . . . plus constant production-line inspection controls and mass-production analyses.

These production-proved SMITHway Certified Electrodes now are available also to you — immediately — from warehouse stocks in principal industrial areas. Phone, wire, or write our nearest office.

Mild Steel . . . High Tensile . . . and Stainless Steel WELDING ELECTRODES

Have You Bought That Extra War Bond This Month?

made by welders . . . for welders

SMITHway A. C. Welding Machine saves power; eliminates arc blow.

SMITHway Welding Monitor trains better welders faster.

A. O. SMITH Corporation

MILWAUKEE • WISCONSIN • HOUSTON • TEXAS

Offices at: NEW YORK, PITTSBURGH, CHICAGO, TULSA, HOUSTON, DALLAS, LOS ANGELES, SEATTLE

In Canada — JOHN INGLIS CO., LIMITED

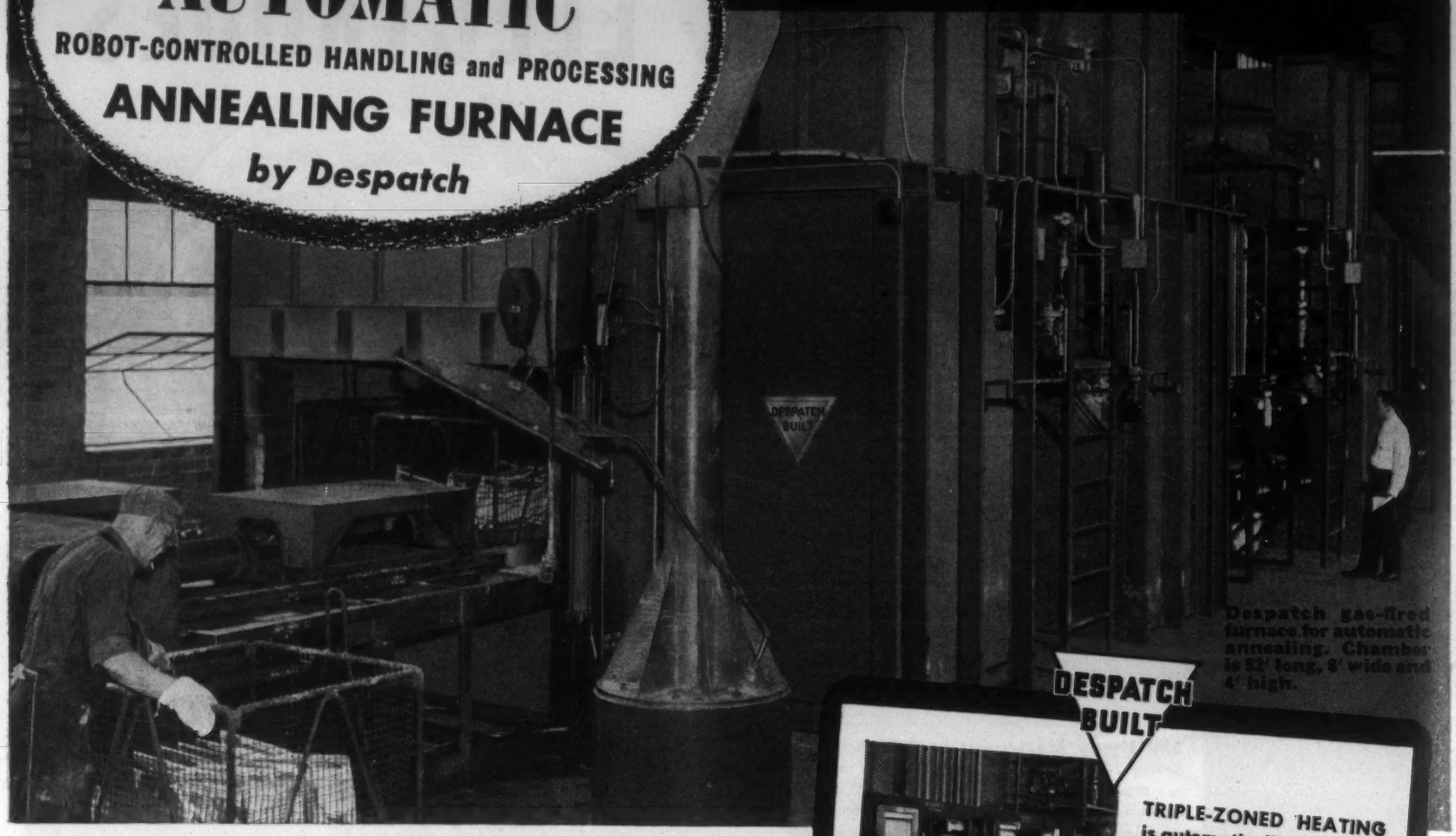
100% AUTOMATIC

ROBOT-CONTROLLED HANDLING and PROCESSING

ANNEALING FURNACE

by Despatch

Another milestone in mechanization!



Despatch gas-fired furnace for automatic annealing. Chamber is 52' long, 5' wide and 4' high.

Requiring no manual effort whatever, save for placing load-baskets in front of chamber entrance, this Despatch "pusher type" furnace subcritically anneals 14,000 lbs. of alloy steel per hour on dual load-lines . . . and meets *all* treatment specifications!

This installation* is typical of Despatch success in building automatic-operating, highly mechanized furnaces to fit *any* industrial requirement.

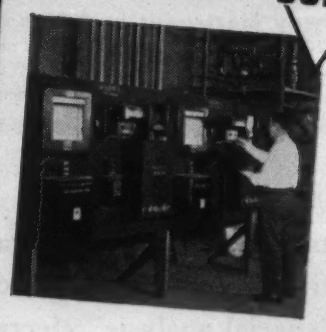
Entire Operation is Time-Cycle Controlled

At predetermined intervals an "unloader" pulls a processed load from zoned-heated chamber while a "pusher" thrusts in new load at opposite end. Each load-line functions independently for additional flexibility.

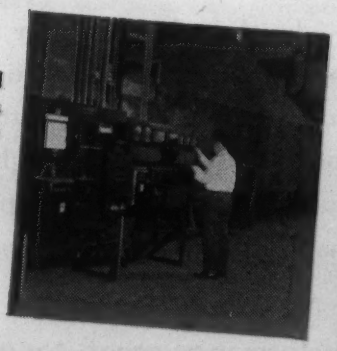
All operations . . . controlled heating, handling of load-baskets, etc. . . . are *automatically* governed from a battery of time-cycle control panels. The furnace is a robot from A to Z!

AVAILABLE IN ANY SIZE are similar Despatch furnaces for *your* heat processing requirements, up to 2400° F. WRITE TODAY for complete details.

DESPATCH BUILT



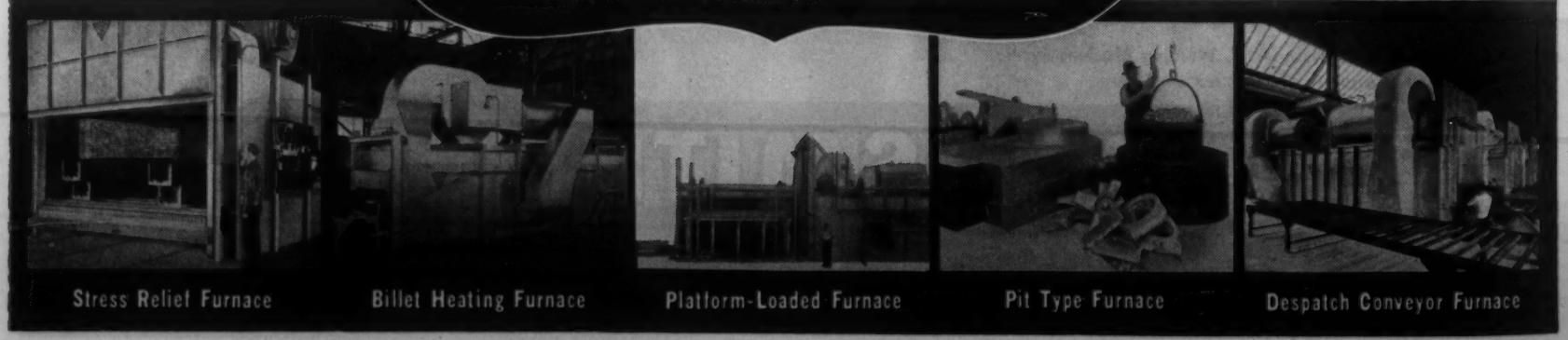
TRIPLE-ZONED HEATING is automatically controlled from panel boards. Note straight line temperature control shown on recorder charts. Assures accurate processing to meet specifications.



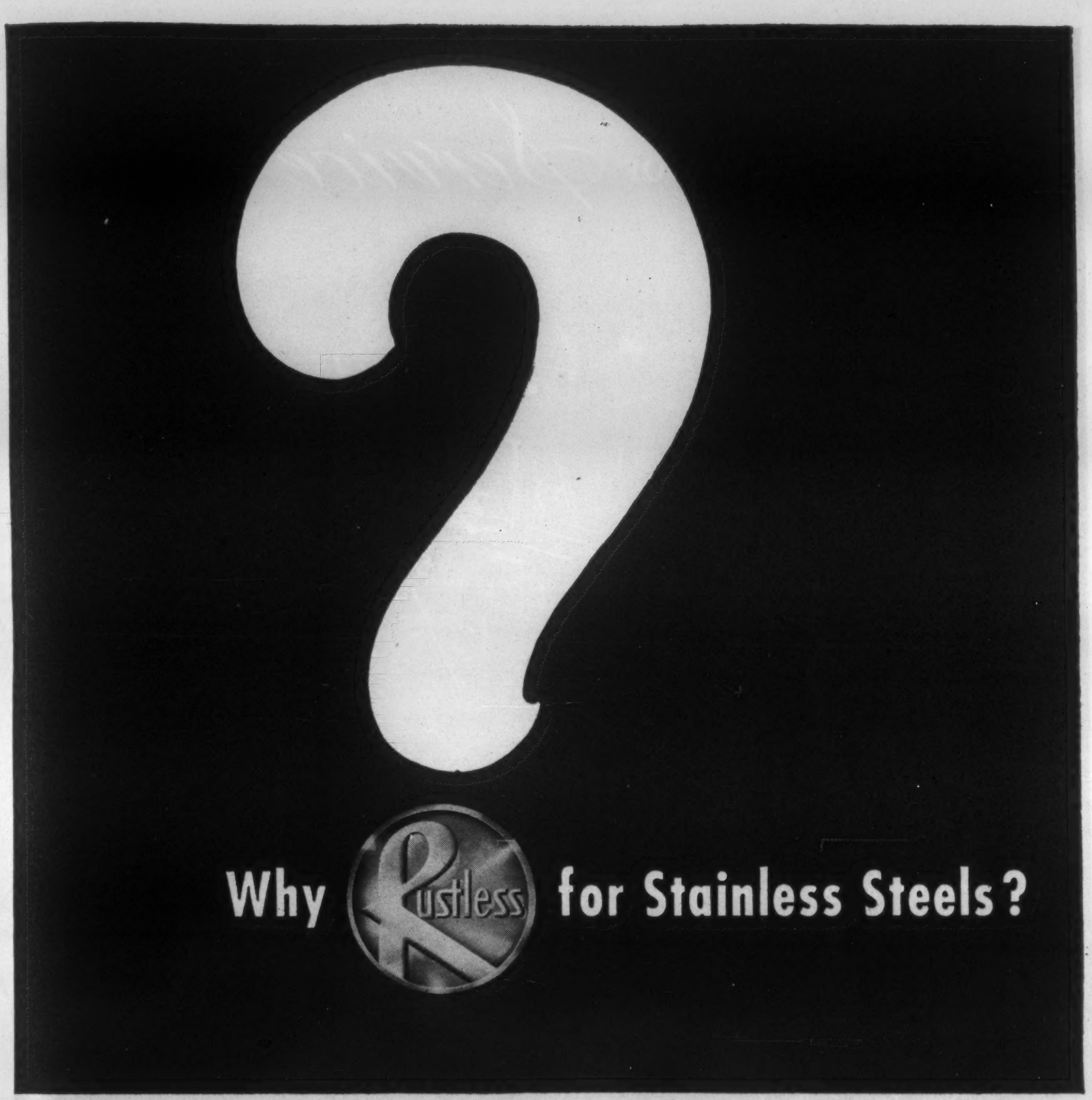
CYCLING PANEL equipped with timer controls. Allows automatic, independent control of pushers, unloaders, etc., for handling 30 load-baskets, 15 on each line.

***A SECOND FURNACE like this is now being installed in the same aircraft plant.**

DESPATCH OVEN COMPANY MINNEAPOLIS 14 MINNESOTA, U.S.A.



Stress Relief Furnace | Billet Heating Furnace | Platform-Loaded Furnace | Pit Type Furnace | Despatch Conveyor Furnace



Why Rustless for Stainless Steels?

RUSTLESS has become one of the most important factors in the stainless steel industry.

One reason for this is that we specialize in the making of stainless steel, and experience has proved to American industry that it pays to deal with a specialist.

Our specialization has enabled us to work successfully with fabricators in solving manufacturing problems that involve machining, forging, cold working, welding, soldering, riveting, heat treating — or in selecting the proper type of stainless in order to obtain ease of fabrication and the economy of long, sometimes limitless life.

Your order, once you place it with us, is not just processed with standard alloy steel mill equipment. We employ many added engineering features that bring stainless steel into uniformly useful form.

Rustless makes stainless steels in over twenty grades readily available, and not only delivers billets, bars and wire, but provides detailed technical assistance with their fabrication. If you want to know more about stainless — ask Rustless.

RUSTLESS

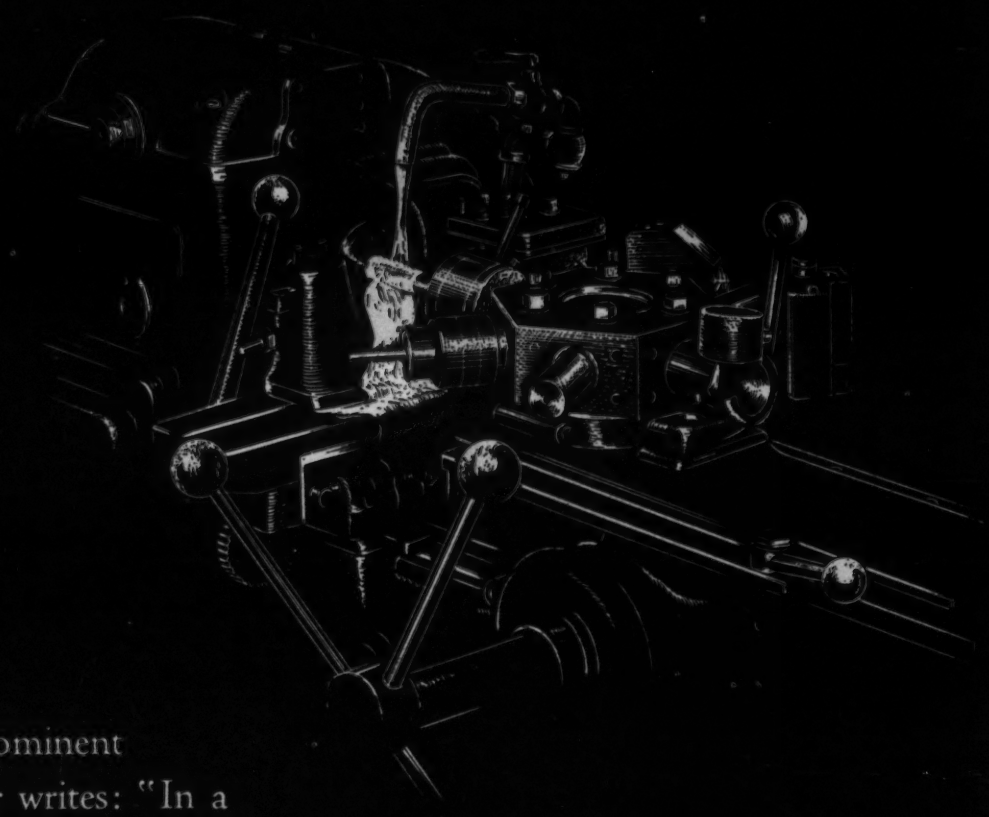
IRON AND STEEL CORPORATION

BALTIMORE 13, MARYLAND

Producing STAINLESS STEELS *Exclusively*

SALES OFFICES: BALTIMORE
BUFFALO • CHICAGO
CINCINNATI • CLEVELAND
DETROIT • LOS ANGELES
MILWAUKEE • NEW YORK
PHILADELPHIA • PITTSBURGH
ST. LOUIS • DISTRIBUTORS
IN PRINCIPAL CITIES

EXAMPLE OF *Service*:



In a recent letter, a prominent industrial manufacturer writes: "In a turret lathe, which usually required a change of tools after every sixth piece, your Chillo Cutting Oil has increased tool life more than 300% and improved finish." For another "Example of Service" write for your *free* copy of METAL CUTTING FLUIDS—26 pages of helpful information. Address: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

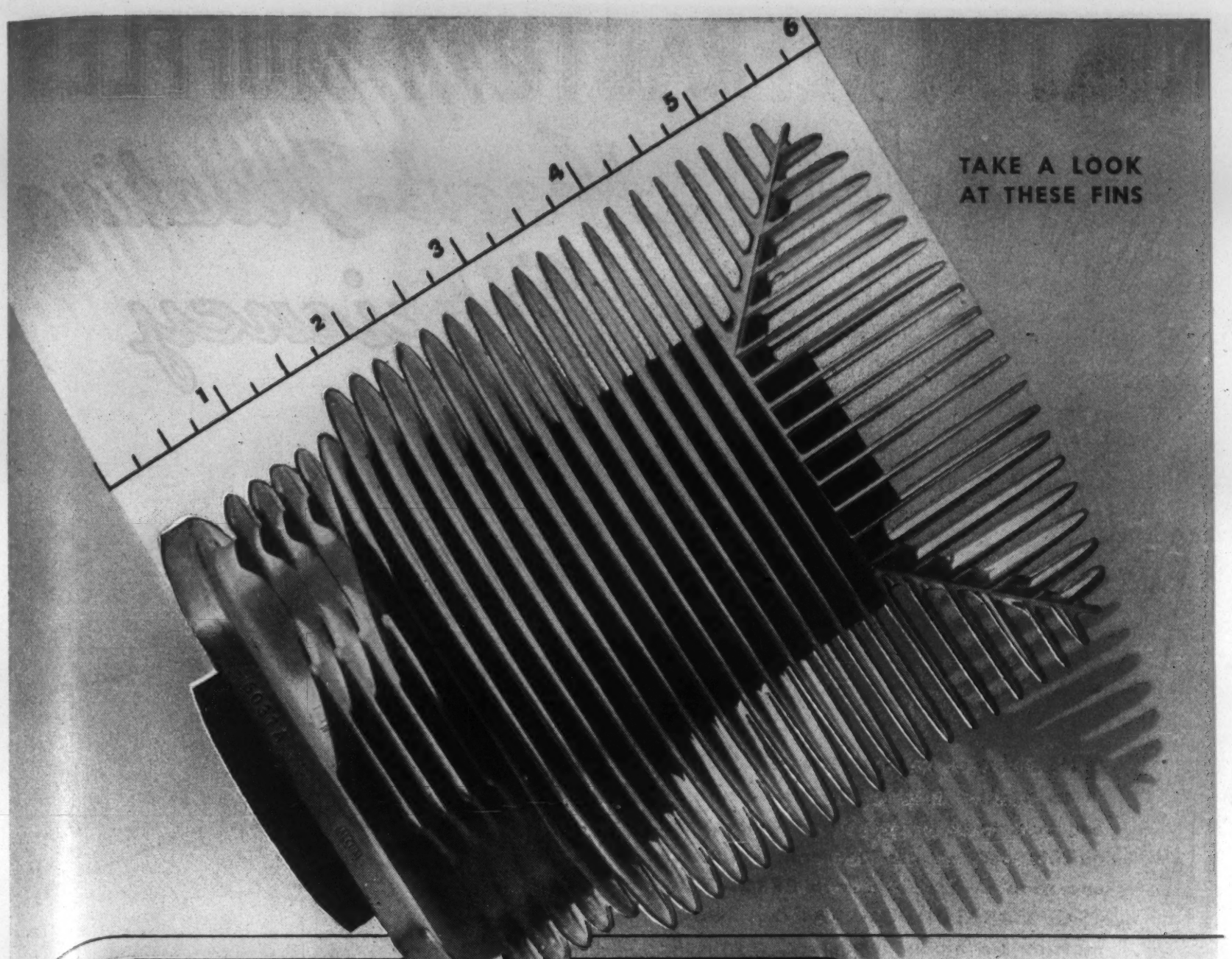
More and more, it's service that counts . . .

and *Cities Service* means good service!

CITIES SERVICE OILS — ONCE-ALWAYS

CITIES SERVICE OIL COMPANY

ARKANSAS FUEL OIL COMPANY



Here's Die Casting Progress

Thinner, deeper and more closely spaced fins have been the trend in die castings like this, designed for rapid heat transfer. Alcoa's Garwood, New Jersey, Plant has pioneered in designing light-metal parts for production by this process, in making dies to produce these increasingly difficult designs, and improving casting techniques.

Manufacturers of engines and compressors have been able to obtain better, more efficient performance from equipment employing these Alcoa die castings. Since all of these products are materials of war, this progress has meant a boost for that effort.

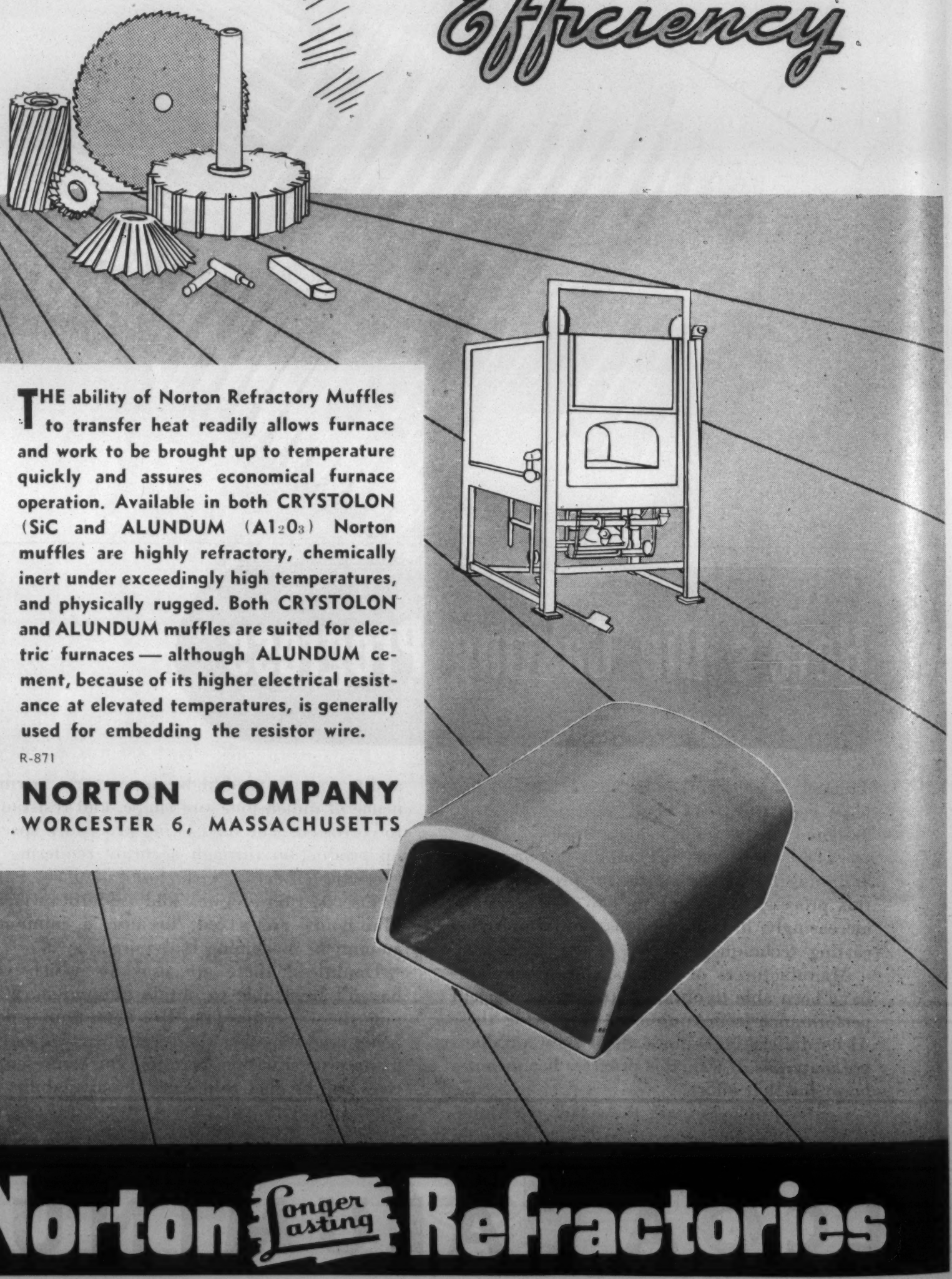
Contributing, too, are these factors: Aluminum provides light weight with high strength, ability to withstand high temperatures, permanence of dimensions and shape, and resistance to corrosion. The die casting procedure speeds up production through accurate rendering of every design detail, with close tolerances, cast-in inserts, thin sections and smooth surfaces. Man-hours are saved, because a minimum amount of machining is required.

Doubtless, there are uses for which you haven't been able to obtain aluminum. Winning the war comes first. But aluminum is now being used for other-than-war purposes, as the manpower situation permits. Our representatives will be glad to discuss the availability of aluminum with you. ALUMINUM COMPANY OF AMERICA, 2162 Gulf Building, Pittsburgh 19, Pa.

ALCOA ALCOA ALUMINUM **ALUMINUM**

NORTON REFRACTORY MUFFLES

for Heat-Treating Efficiency

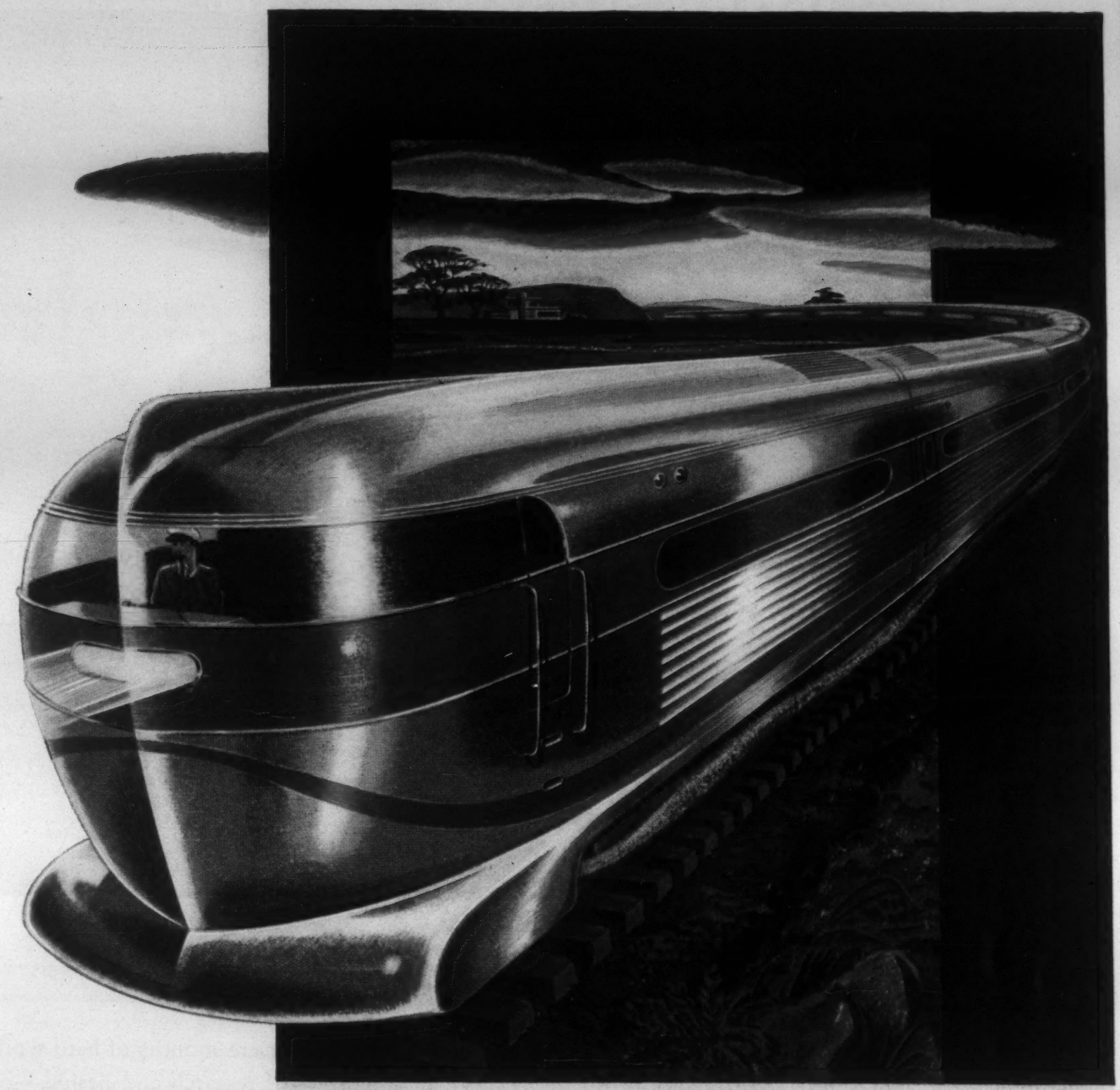


THE ability of Norton Refractory Muffles to transfer heat readily allows furnace and work to be brought up to temperature quickly and assures economical furnace operation. Available in both CRYSTOLON (SiC and ALUNDUM (Al_2O_3) Norton muffles are highly refractory, chemically inert under exceedingly high temperatures, and physically rugged. Both CRYSTOLON and ALUNDUM muffles are suited for electric furnaces — although ALUNDUM cement, because of its higher electrical resistance at elevated temperatures, is generally used for embedding the resistor wire.

R-871

NORTON COMPANY
WORCESTER 6, MASSACHUSETTS

Norton Longer Lasting **Refractories**



In the sunrise of post-war
Railroad Transportation

SLEEK luxury trains, gleaming with the beauty of stainless steel, fashioned in designs expressing the civilization of a peacetime world . . . they are coming, over the horizon! Ready for use in their fabrication will be Superior Stainless Strip Steel . . . *long coils* of permanently bright, solidly enduring, exceedingly strong metal, in any standard analysis and rolled to exact size . . . serving to equal advantage the designers, builders, owners of tomorrow's finer trains.

Superior
STAINLESS
STRIP STEEL

Superior Steel
CORPORATION
CARNEGIE · PENNSYLVANIA

...To Engineer A New Product!

This little self-locking nut plate is typical of Solar's challenging spirit which, fifteen years ago, brushed aside tradition to give the world the first really safe method of venting dangerous airplane gases—the Solar stainless steel exhaust manifold.

Two years ago there was a desperate need for self-locking nut plates for military plane production which would sustain high temperatures. Solar met the emergency with SOL-A-NUT... a stainless steel nut plate developed with Solar initiative on different principles of design and construction. SOL-A-NUT is simplicity itself—*now that it is finished.* But back of it are months of hard work and original thinking—of research and design—of material tests—trials in use—re-design and further tests.

It is not a simple matter to engineer new products, particularly those made of stainless steel and used where high temperatures prevail, or hot gases, acids and corrosion are encountered. The machinery and metal working industries—where such conditions surround the use of products and equipment—is a particular field in which Solar's experience and knowledge would be at its best. Consult Solar on your problems. Address "Management".

ARMY E NAVY ARMY E NAVY

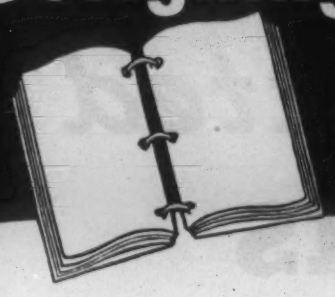
SOLAR

STAINLESS STEEL PRODUCTS

SOLAR

SOLAR AIRCRAFT COMPANY SAN DIEGO 12, CALIF. DES MOINES 5, IA.

Designing Molded Plastics Parts: LOW TEMPERATURES



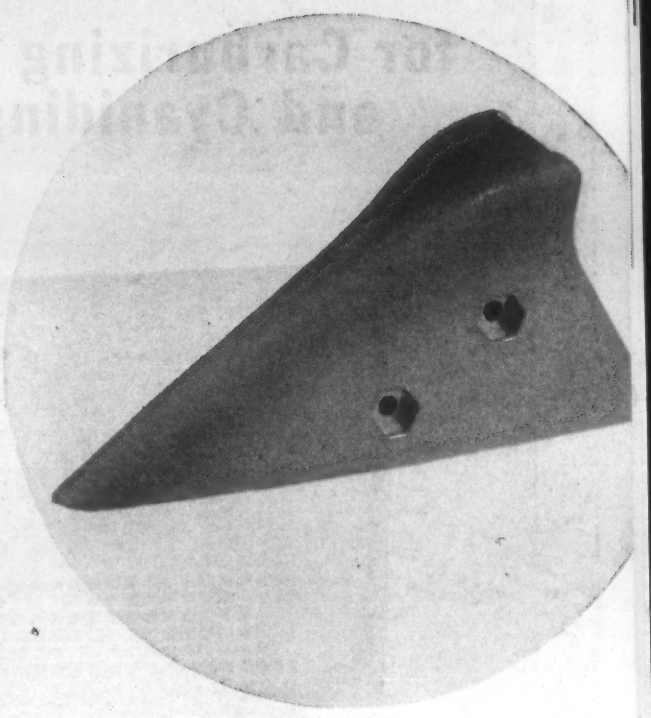
From the engineering files of One Plastics Avenue

Plastics are much more sensitive to relatively slight changes in temperature than are the metals. This reflects itself principally in a change in mechanical properties, although electrical and chemical properties are also affected.

Because they are "plastic," plastics show an increasing tendency to cold flow as the temperature increases, and conversely, an increase in rigidity as the temperature decreases. This increase in rigidity makes the material stiffer and more brittle, which reflects itself in an increase in tensile strength and modulus of elasticity and a decrease in impact strength. This is especially true of most of the thermoplastics.

Thermosetting materials, such as the phenolics, ureas, and melamines, are more rigid because of their cross linked structure, and are comparatively unaffected by a decrease in temperature.

Applications in which these considerations are especially important are parts for aircraft which are commonly subjected to −40°C. Refrigerator parts may also be subjected to sub-zero temperatures. Extruded plastic tubing may have to retain its flexibility at very low temperatures. Thermoplastics to be used outdoors may have to be especially selected for low temperature use.



This molded airplane fairing retains its high impact strength when tested at a temperature of −80° C.

Mechanical Properties At -80°C As Compared To Those At 25°C

	Tensile	Impact	Modulus of Elasticity
Phenol - Wood flour	100%	100%	130%
Fabric	120%	80%	
Asbestos	110%	105%	
Urea			140%
Melamine		100%	
Polystyrene	170%	100%	140%
Methacrylate	150%	100%	> 200%
Cellulose Acetate	200%	20%	120%
Ethyl Cellulose	150%	20%	

REPRINTS of this advertisement may be obtained by writing Section F-223 General Electric Plastics Divisions, One Plastics Avenue, Pittsfield, Mass.

Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 P.M. EWT, NBC. "The World Today" news every weekday 6:45 P.M. EWT, CBS.

BUY WAR BONDS

PD-223

GENERAL ELECTRIC

MISCO *Fabricated* Alloy Products

HEAT AND CORROSION RESISTANT

for Carburizing • Annealing • Hardening • Nitriding and Cyaniding in Air Furnaces and Salt Baths

Misco fabricated trays for nitriding. Operating temperature 930°. Permits maximum load per unit space and uniform flow of gasses.

To users of heat treating equipment Misco offers complete facilities for the fabrication of containers, fixtures and miscellaneous alloy products.

Made from rolled material or used in combination with alloy castings, the construction of Misco Fabricated Alloy Products can be varied to suit operating conditions, whether the duty is normal or extremely severe.

With Misco sheet, castings, bars, wire, bolts, nuts and rivets at our disposal—and a reliable welding technique, we are able to make up fabricated heat treating equipment, large or small, with equal facility.

We will be pleased to quote from your own details or to offer suggestions on redesign problems.

Other MISCO Heat-Treating EQUIPMENT

Furnace Parts • Roller Rails • Conveyors • Roller Hearths • Conveyor Rolls • Trays • Retorts • Thermocouple Protection Tubes • Chain • Walking Beam Conveyors • Carburizing and Annealing Boxes • Dipping Baskets • Cyanide and Lead Pots • Centrifugal Castings and Miscellaneous Castings for use at high temperature or under corrosive conditions.

★ ★ ★

Invest all you can in U. S. WAR BONDS

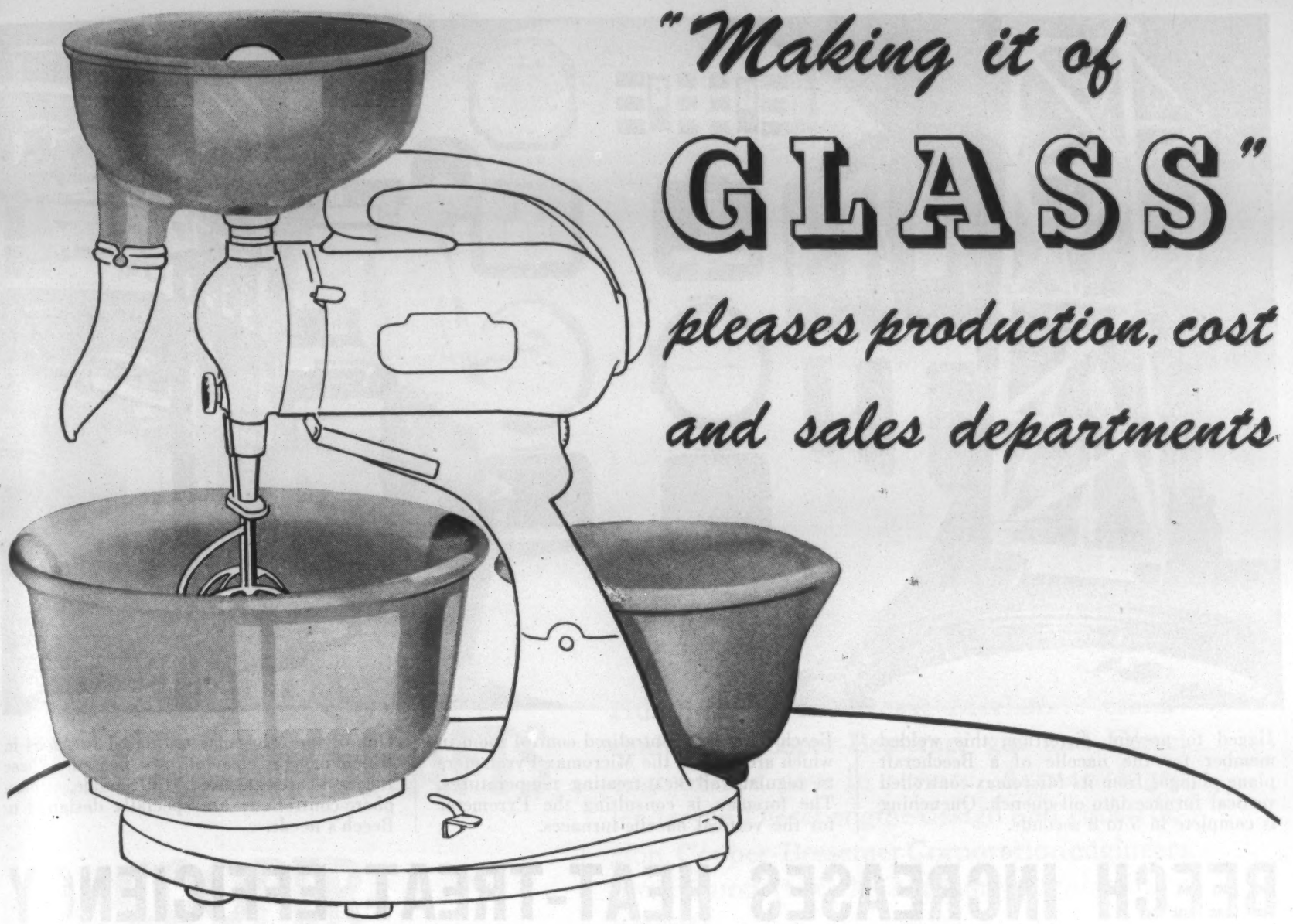
★ ★ ★

MISCO
Heat and Corrosion Resistant Alloys

Michigan Steel Casting Company

One of the World's Pioneer Producers of Heat and Corrosion Resistant Alloy Castings

1999 GUOIN STREET, DETROIT 7, MICHIGAN



"Making it of GLASS" pleases production, cost and sales departments

Hamilton-Beach were searching for a set of "out-of-the-ordinary" Mixing Bowls that would add to the sales appeal of their product.

They came to Corning, and Corning engineers came back with the answer with bowls of colorful Glo-Flec* which add much to the beauty, serviceability and saleability of Hamilton Beach food mixers.

The manufacturing techniques developed by Corning permit the production of these glass parts automatically, in quantity and at low cost. These methods result in a more accurate, and less expensive product than could be made by hand—and one with uniform color and sparkling quality.

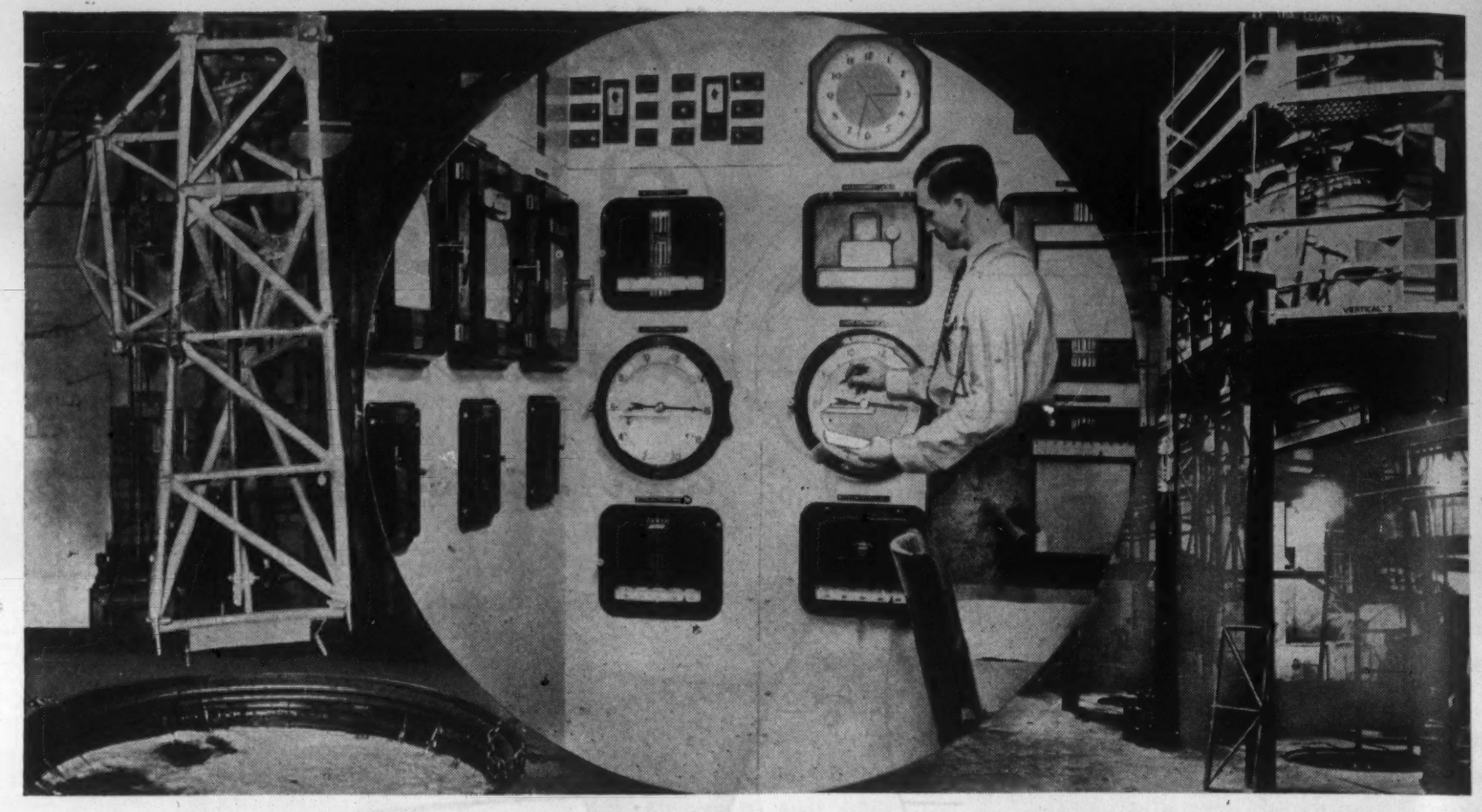
Whatever your needs—whether for a single glass part of intricate design, or thousands of similar parts, Corning engineers and Corning manufacturing facilities can help you solve your problems. Product designers who are anxious to be a step ahead of competition, will do well to consult with Corning on how glass can improve their products and lower their costs. Write for Bulletin 842, "Industrial Glass by Corning," Industrial Sales Dept., MA12, Corning Glass Works, Corning, New York.

**Glo-Flec is but one of the thousands of special glasses which Corning has developed and from which you can select the one with the characteristics to meet your particular requirements.*

"CORNING" is a registered trade-mark and indicates manufacture by Corning Glass Works, Corning, New York.

CORNING
Glass Works
Corning, New York

Corning Industrial Glass
BRAND



Jigged to prevent distortion, this welded member for the nacelle of a Beechcraft plane plunges from its Micromax-controlled vertical furnace into oil quench. Quenching is complete in 5 to 8 seconds.

Beech Aircraft's centralized control room in which are located the Micromax Pyrometers to regulate all heat-treating temperatures. The foreman is consulting the Pyrometer for the vertical nacelle-furnaces.

One of the Micromax-regulated furnaces in which nacelle elements are heated. These furnaces are gas-fired, full muffle, atmosphere-controlled; are specially designed to Beech's needs.

BEECH INCREASES HEAT-TREAT EFFICIENCY By Centralizing Its Micromax Controllers

Heat-treating operations performed in the Beech Aircraft Corp. plant at Wichita, Kansas, include case hardening, annealing, normalizing, stress-relieving, hardening, etc. The job of automatically controlling the temperatures of these operations has been turned over to Micromax Pyrometers, with the result that their micro-responsive control is giving Beech routinely dependable heat-treatment.

For utmost efficiency, instruments are centralized in a specially-designed control room. Here all Micromax Controllers have the same ambient temperatures; all operating conditions are standardized; one man keeps all temperatures under his eye. The room is supplied with air at a slight positive pressure so that dust and fumes cannot enter—a valuable time-saver when pyrometers, hardness testers and other instruments are to be kept at optimum accuracy and dependability.

Instrumentation of Vertical Furnaces

Typical of the special equipment employed is that for airplane nacelles. These are hardened in vertical furnaces, set well up in the air and directly above the quench tanks. The furnaces are muffle units, gas fired and supplied with specially prepared atmosphere to prevent oxidation or other change of the plane parts. Nacelles are quenched through doors in the furnace bottoms.

These furnaces have three firing zones, each with its Micromax Controller. In the round picture above, one group of three Controllers can be seen directly below the clock; the top and bottom instruments, on the first and third zones, are Indicating Controllers, while the middle zone has the Recording Controller which the foreman is examining.

These instruments bring micro-responsiveness to temperature regulation, so that almost simultaneously with the appearance of heat lags or surges, the fuel valves are adjusted to bring temperature back to the control point. Equipments incorporate the outstanding features of Micromax design: sturdy machine-type parts; extra-heavy gears, shafts and bearings; fine construction throughout.

Further information will be sent on request; either a general catalog or specific engineering data, as you prefer.

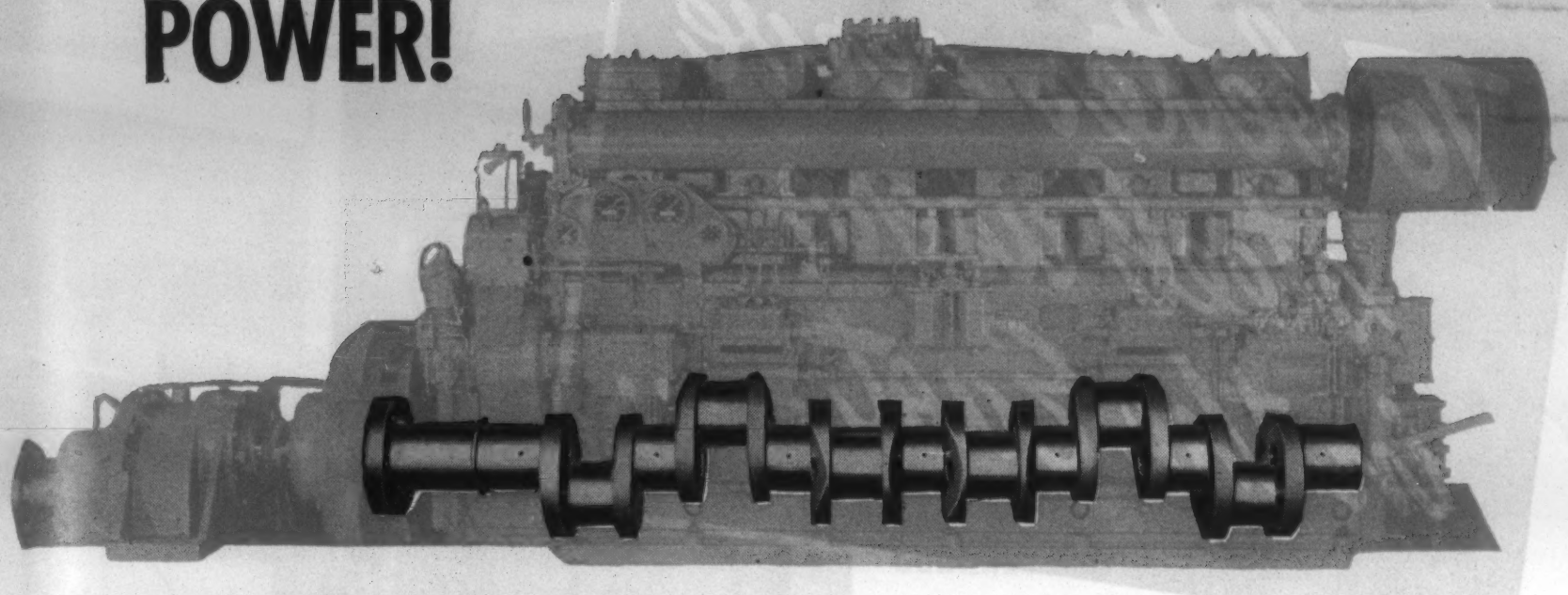
Jrl Ad N-33-620(9)

LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

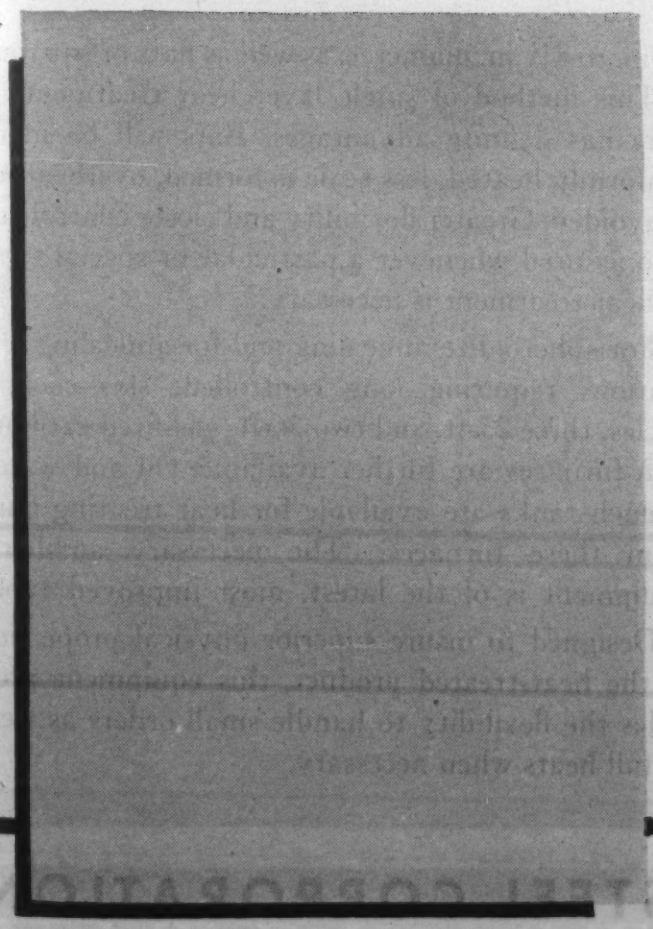
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

DEPENDABLE POWER!



MEEHANITE CRANKSHAFTS

COOPER-BESSEMER ENGINES



Hundreds of these cast Meehanite crankshafts in Cooper-Bessemer gas and Diesel engines are now in service. Acknowledged leaders in Diesel engine design and construction, Cooper-Bessemer Corporation engineers have found that the Meehanite crankshafts permit:

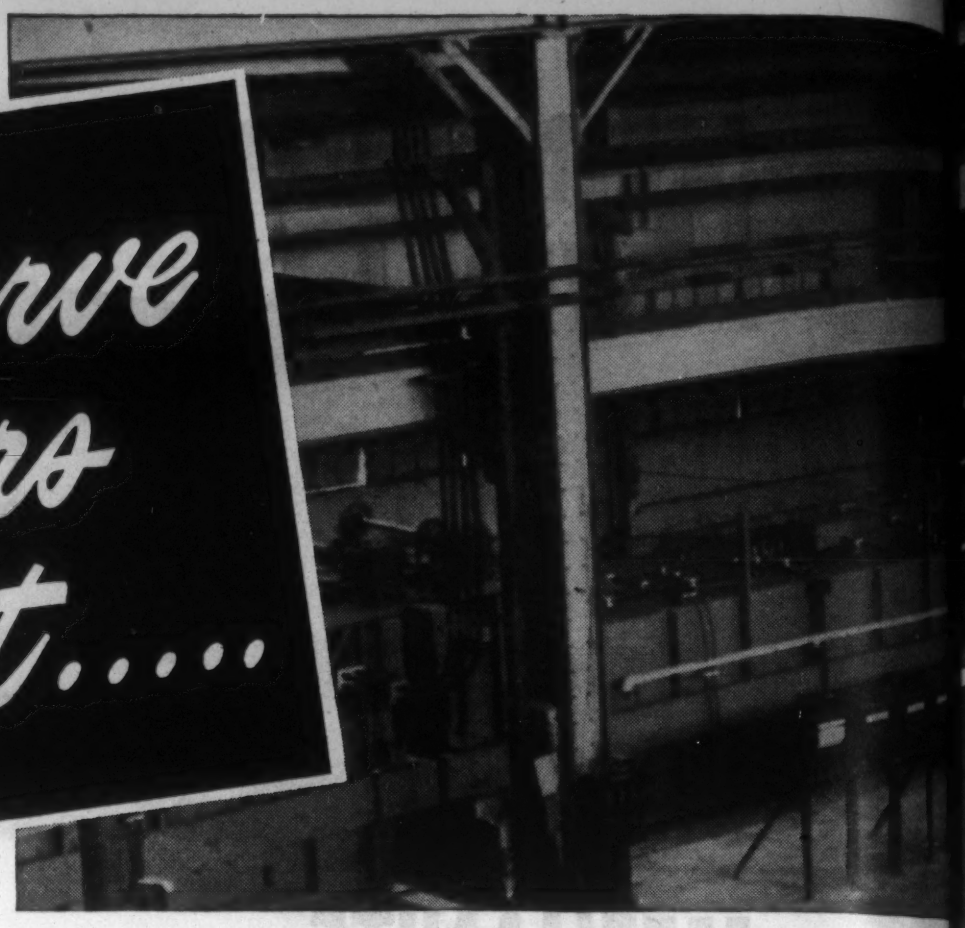
1. **Design to better engineering principles**
2. **Better stress distribution**
3. **Higher vibration absorption**
4. **Adequate tensile, torsional and fatigue strength**

Utilizing the dependable mechanical properties of Meehanite for other parts, Cooper-Bessemer engines contain several hundred Meehanite Castings as units of construction.

These and the other superior properties of Meehanite Castings are being utilized daily in practically every industry where castings are used. If you are planning a new product or redesigning your present ones, consult a Meehanite foundry.

MEEHANITE QUALITY CONTROL ASSURES UNIFORM DEPENDABILITY

MEEHANITE RESEARCH INSTITUTE
NEW ROCHELLE, N. Y.



To better serve steel users in the East.....

New and special heat-treating equipment now available at Pittsburgh...*has capacity to handle 25,000 tons of rolled alloy steel products annually*

THIS NEW HEAT-TREATING equipment places at the disposal of alloy steel users in the Eastern area the latest and most advanced mechanical and metallurgical developments in the fine art of annealing and heat treatment. It supplements the 158,400-ton annual capacity for producing electric furnace steel now in operation at our Duquesne Works, near Pittsburgh.

High, uniform quality is insured by a novel, 7-chamber, continuous furnace electrically heated and automatically controlled. It is used for production line service in heat treating bars which require quenching and drawing operations, normalizing or annealing, including special types of anneals such as sub-critical or by isothermal transformation.

So arranged that it may be operated in a continuous 366-ft. hardening and tempering line, this furnace will handle a *single layer* of 25-ft. bars, from ⅜ in. to 8¼ in. diameter, as well as flats or squares.

This method of single layer heat treatment of bars has definite advantages. Bars will be more uniformly heated, less scale is formed, overheating is avoided. Greater flexibility and closer control are also assured whenever a particular or special type of heat treatment is necessary.

For spheroidize annealing and for annealing operations requiring long controlled, slow-cooling cycles, three 25-ft. and two 36-ft. gas-fired car bottom furnaces are further available. Oil and water quench tanks are available for heat treating bars from these furnaces. The necessary auxiliary equipment is of the latest, most improved type.

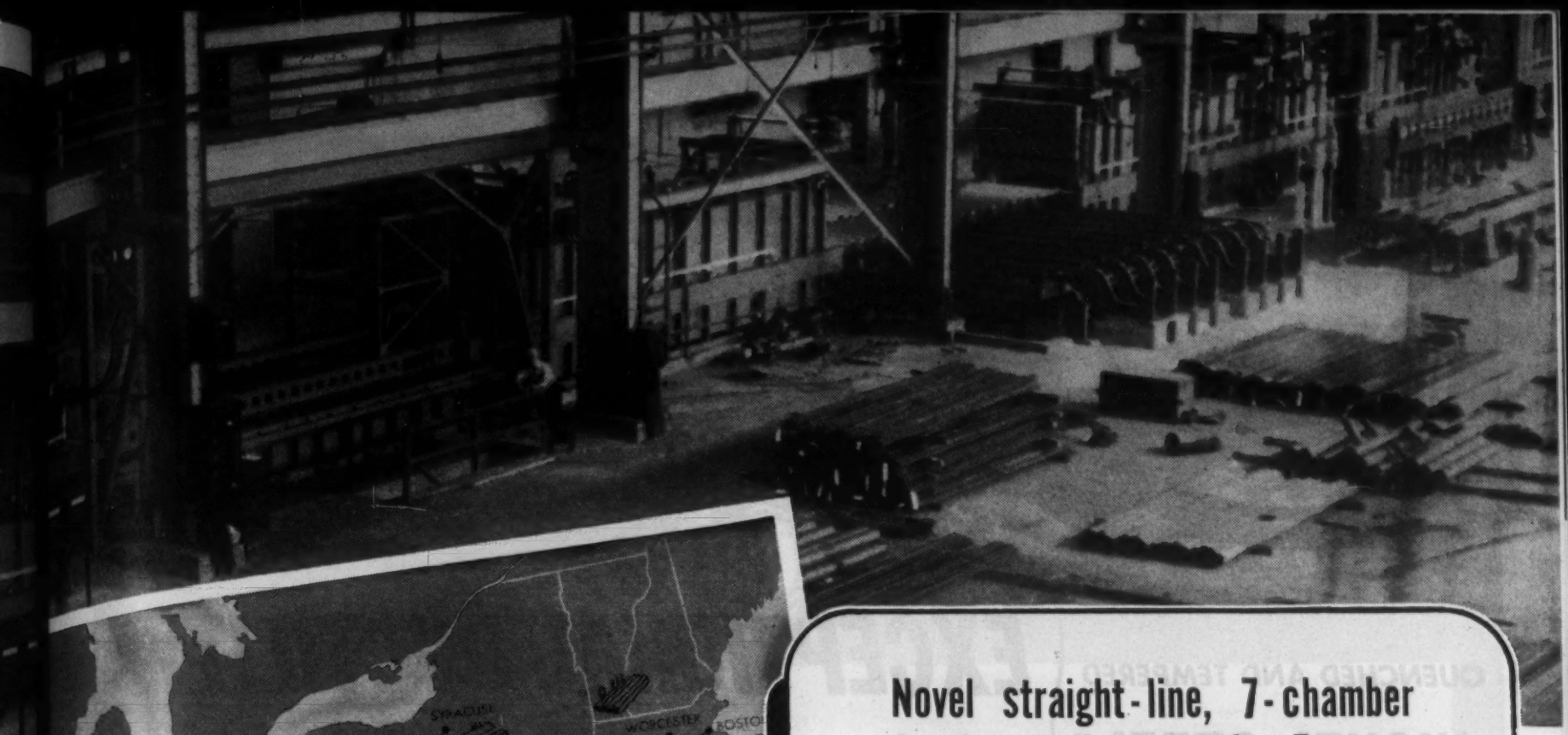
Designed to insure superior physical properties in the heat-treated product, this equipment provides the flexibility to handle small orders as well as full heats when necessary.

USS

CARNEGIE-ILLINOIS STEEL CORPORATION

Pittsburgh and Chicago

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
United States Steel Export Company, New York



Novel straight-line, 7-chamber Continuous Heat-treating Furnace assures high and uniform quality

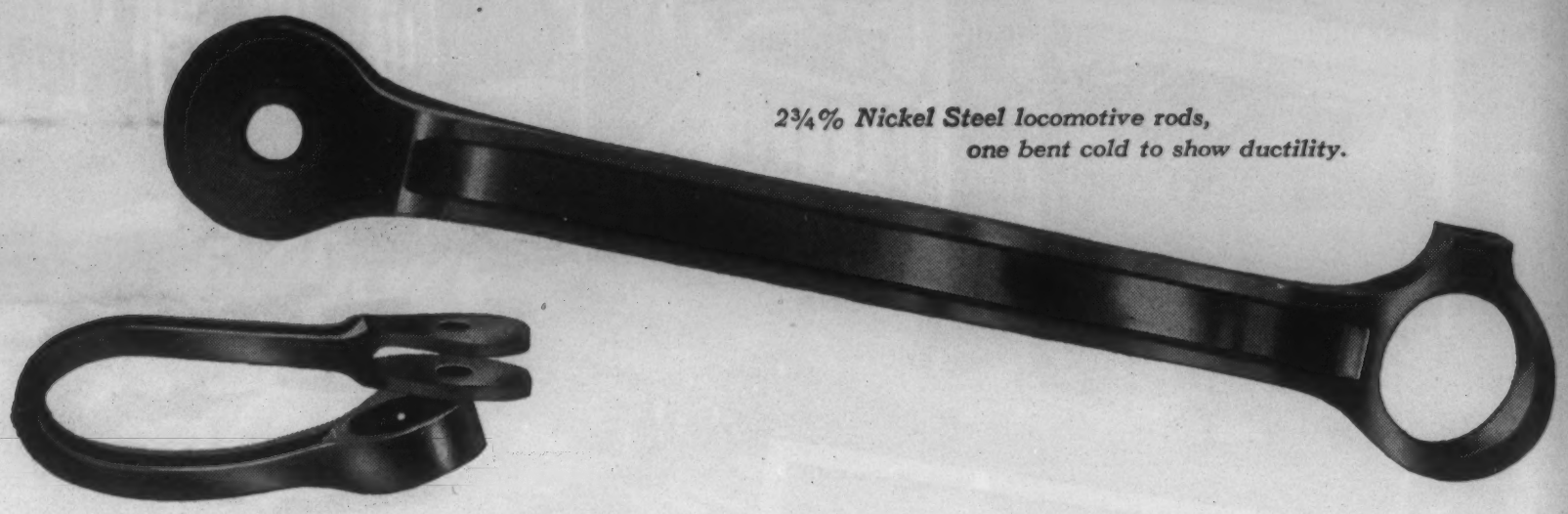
In sequence of operation, the line consists of (1) a heating section divided into preheating, intermediate, and high temperature chambers, each with separate doors; (2) a quenching tank for either oil or water quenching under automatic cycle control; (3) a strain-relief furnace; (4) center discharge and cross-feed transfer table, and (5) a tempering section. This last section, like the heating section, is also divided into three chambers, each with separate doors.

Extreme flexibility is obtained in the unit by the discharge table and cross-feed conveyor located between the strain-relief and tempering section. At this table, bars that are normalized or annealed and which do not require a tempering operation can be removed and routed for further processing. Our metallurgists will be glad to discuss in detail the benefits that this equipment can effect in improving the annealed, or quenched and tempered bar products that you use.

• • •

(Below) *Battery of batch-type furnaces for annealing, quenching and drawing. Two 25-ft. furnaces at right foreground, two 36-ft. furnaces at center, another 25-ft. furnace at extreme left.*

UNITED STATES STEEL



2¾% Nickel Steel locomotive rods, one bent cold to show ductility.

QUENCHED AND TEMPERED

NICKEL STEEL

FORGINGS COMBINE

EXCEPTIONAL DUCTILITY

WITH

HIGH TENSILE STRENGTH

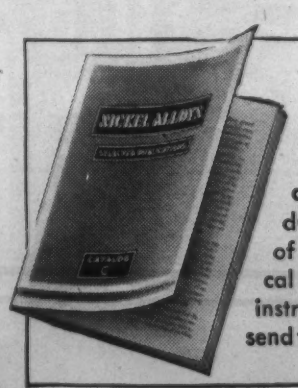
Composition and Typical Properties of Normalized Quenched and Tempered 2¾% Nickel Steel Rods

Description or Size	Melt Yield Pt. No. #s per Sq. In.	Tensile Strength #s per Sq. In.	Elong. % in 2 In.	Reduction in Area %	ANALYSIS					
					Car.	Mang.	Phos.	Sul.	Sil.	Ni
Main Rod....	92900	110000	25.0	64.4	.31	.78	.027	.026	.25	2.75
Main Rod....	86500	104500	25.5	65.6	.32	.86	.034	.032	.29	2.69
Main Rod....	86360	104400	26.0	64.8	.32	.86	.034	.032	.29	2.69
Main Rod....	87850	102350	26.0	66.2	.31	.89	.037	.025	.32	2.69
Front Rod....	86000	102250	25.0	67.3	.29	.82	.035	.027	.24	2.71
Front Rod....	83900	104250	25.0	66.1	.29	.82	.035	.027	.24	2.71
Front Rod....	86850	104250	27.0	66.1	.32	.86	.035	.025	.30	2.65
Front Rod....	89500	107050	25.5	65.6	.32	.86	.035	.025	.30	2.65
Back Rod....	89500	107650	25.0	62.7	.30	.79	.030	.025	.22	2.71
Back Rod....	87500	106450	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	87000	105600	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	88150	104850	26.0	66.8	.29	.82	.035	.027	.24	2.71

Specimens Taken from Mid-Section of Prolongations of the Forgings

The above table compiled by the American Locomotive Company shows the chemical compositions and mechanical properties of some normalized, quenched and tempered nickel steel front, main and back rods recently produced as replacement rods for locomotives being speeded up and rebalanced. These values are typical of replacement rod forgings recently tested by that company.

Quenched and tempered nickel steel forgings provide high tensile strength and ductility, combined with unusual toughness and high fatigue strength—qualities which tend to obviate breakage and assure long, trouble-free service when employed in heavy duty machinery and equipment.



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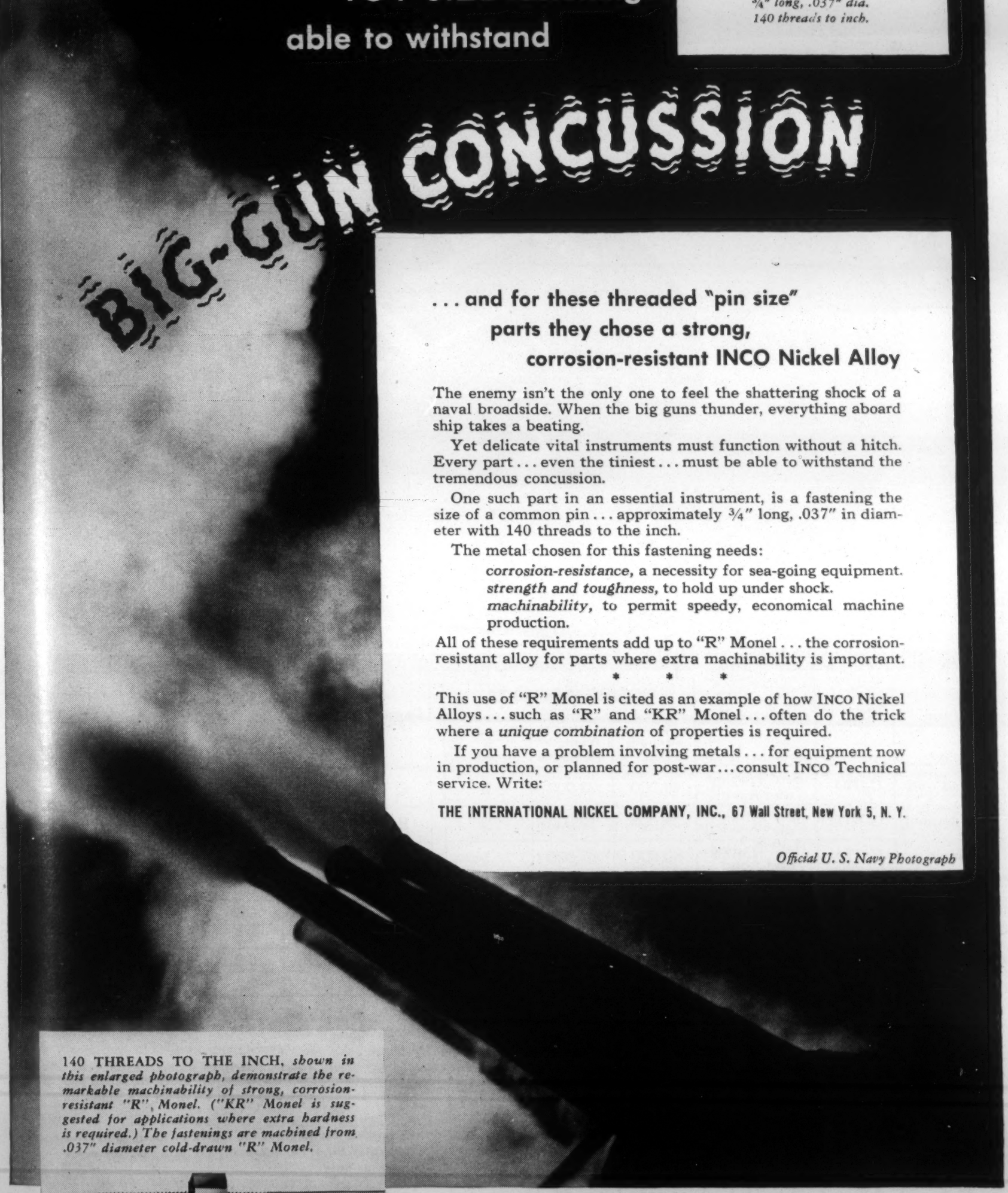
★ **Nickel** ★

THE INTERNATIONAL NICKEL COMPANY, INC., *67 Wall Street, New York 5, N. Y.*

They wanted TOY-SIZE fastenings able to withstand BIG-GUN CONCUSSION

¾" long, .037" dia.
140 threads to inch.



. . . and for these threaded "pin size" parts they chose a strong, corrosion-resistant INCO Nickel Alloy

The enemy isn't the only one to feel the shattering shock of a naval broadside. When the big guns thunder, everything aboard ship takes a beating.

Yet delicate vital instruments must function without a hitch. Every part . . . even the tiniest . . . must be able to withstand the tremendous concussion.

One such part in an essential instrument, is a fastening the size of a common pin . . . approximately ¾" long, .037" in diameter with 140 threads to the inch.

The metal chosen for this fastening needs:

corrosion-resistance, a necessity for sea-going equipment.
strength and toughness, to hold up under shock.
machinability, to permit speedy, economical machine production.

All of these requirements add up to "R" Monel . . . the corrosion-resistant alloy for parts where extra machinability is important.

* * *

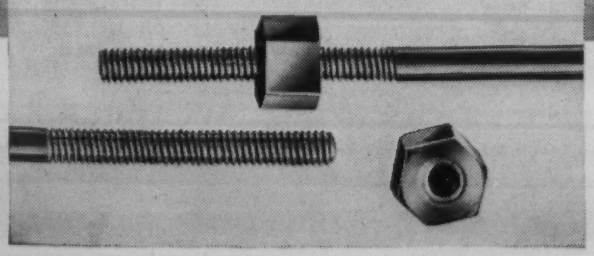
This use of "R" Monel is cited as an example of how INCO Nickel Alloys . . . such as "R" and "KR" Monel . . . often do the trick where a *unique combination* of properties is required.

If you have a problem involving metals . . . for equipment now in production, or planned for post-war . . . consult INCO Technical service. Write:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York 5, N. Y.

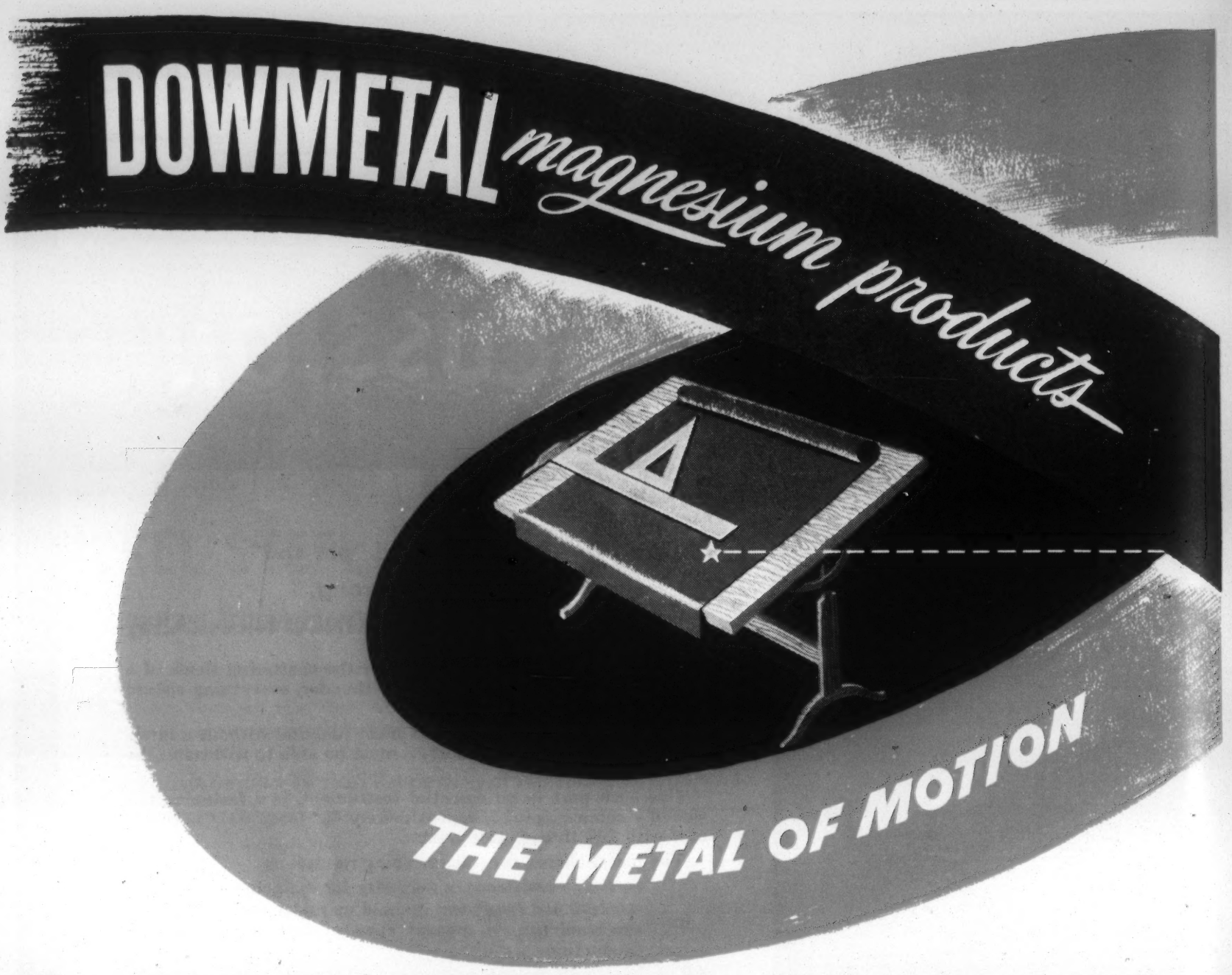
Official U. S. Navy Photograph

140 THREADS TO THE INCH, *shown in this enlarged photograph, demonstrate the remarkable machinability of strong, corrosion-resistant "R" Monel. ("KR" Monel is suggested for applications where extra hardness is required.) The fastenings are machined from .037" diameter cold-drawn "R" Monel.*



INCO NICKEL ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL
Sheet . Strip . . . Rod . . . Tubing . . . Wire . . . Castings



Form	Dowmetal Alloy	Condition	TYPICAL PROPERTIES		
			Tensile Strength lb./sq. in.	Yield Strength[1] lb./sq. in.	Elongation % in 2 in.
Sand and Permanent Mold Cast	C-HTA	Heat Treated and Aged	40,000	23,000	2
	G-HTA	Heat Treated and Aged	34,000	19,000	2
	H-HTA	Heat Treated and Aged	40,000	19,000	5
	M	As Cast	14,000	4,500	5
Die Cast	R	As Cast	33,000	21,000	3
Forged	J-1	As Forged	43,000	26,000	12
	M[2]	As Forged	36,000	23,000	7
	O-1	As Forged	46,000	31,000	8
	O-1A	Aged	50,000	34,000	6
Extruded Bars[3]	FS-1	As Extruded	40,000	30,000	15
	J-1	As Extruded	45,000	32,000	15
	M	As Extruded	38,000	26,000	10
	O-1	As Extruded	49,000	33,000	11
	O-1A	Aged	50,000	34,000	7
Sheet, Plate, and Strip	FS-1a	Annealed	37,000	22,000	21
	FS-1h	Hard Rolled	43,000	33,000	11
	J-1a	Annealed	43,000	26,000	16
	J-1h	Hard Rolled	47,000	34,000	9
	M-a	Annealed	33,000	15,000	17
	M-h	Hard Rolled	37,000	29,000	18

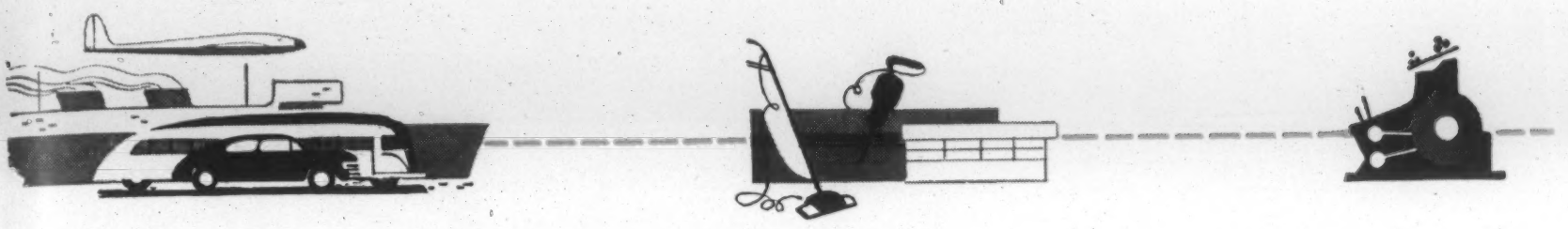
Dowmetal Alloy	COMPOSITIONS			
	Aluminum	Manganese	Zinc	Magnesium
C	9.0	0.1	2.0	Remainder
H	6.0	0.2	3.0	Remainder
G	10.0	0.1	3.0	Remainder
FS-1	3.0	0.3	1.0	Remainder
J-1	6.5	0.2	1.0	Remainder
M	. . .	1.5	. . .	Remainder
O-1	8.5	0.2	0.5	Remainder
R	9.0	0.2	0.6	Remainder

[1] Yield strength is defined as the stress at which the stress-strain curve deviates 0.2% from the modulus line.

[2] Properties for M alloy are based on both press and hammer forgings, those for J-1 and O-1 on press forgings only.

[3] The properties for bars and rods apply to sizes from ¼ to 1½ in. diameter or 2½ square inches.

DATA FOR PRODUCT DESIGNERS



PERTINENT ENGINEERING FACTS ON INDUSTRY'S LIGHTEST METAL

Number 6 in a Series

RELATIVE WEIGHTS OF STRUCTURAL METALS				
Material	Specific Gravity	Relative Weight	Weight	
			lb./cu. in.	lb./cu. ft.
Magnesium Alloys	1.8	1.0	0.065	112
Aluminum Alloys	2.8	1.6	0.101	175
Zinc	7.1	3.9	0.256	443
Cast Iron	7.2	4.0	0.260	450
Tin	7.3	4.1	0.264	456
Steel	7.9	4.4	0.285	493
Brass	8.5	4.7	0.307	531
Bronze	8.8	4.9	0.318	550
Nickel	8.9	4.9	0.322	556
Copper	8.9	4.9	0.322	556
Lead	11.3	6.3	0.408	706

Magnesium is a full third lighter than the lightest of other structural metals. This fact, combined with magnesium's exceptionally high strength-weight ratio, offers the alert designer a broad yet clearly-defined field of opportunity for new products and for the improvement and increased sales appeal of established products. Some important pertinent data on Dowmetal Magnesium Alloys are included in the Tables (left and above) and in the following:

CHEMICAL PROPERTIES: Dowmetal resists the attack of most alkalies and of many organic chemicals including hydrocarbons, some aldehydes, acetones, alcohols, phenols, amines, esters, and most oils; it is resistant to attack by pure chromic acid and concentrated hydrofluoric acid as well as solutions of alkali metal arsenates, fluorides, chromates, and dichromates. Other acids and aqueous salt solutions attack the metal in varying degree.

WEAR RESISTANCE: Dowmetal can be used directly for bearings with comparatively light service and good lubrication. Journal hardness should be as high as possible, preferably about 600 Brinell. For heavy service, metal liners or inserts are recommended.

YIELD STRENGTH: In contrast to mild steel, Dowmetal exhibits no definite yield point; rather, it shows a tendency to yield gradually under stress.

MODULUS OF ELASTICITY: Dowmetal's modulus of elasticity is 6,500,000 pounds per square inch. The elastic energy absorption capacity is especially high as a result of this low modulus. Where deflection rather than stress governs the design, the modulus of elasticity should be taken into consideration.

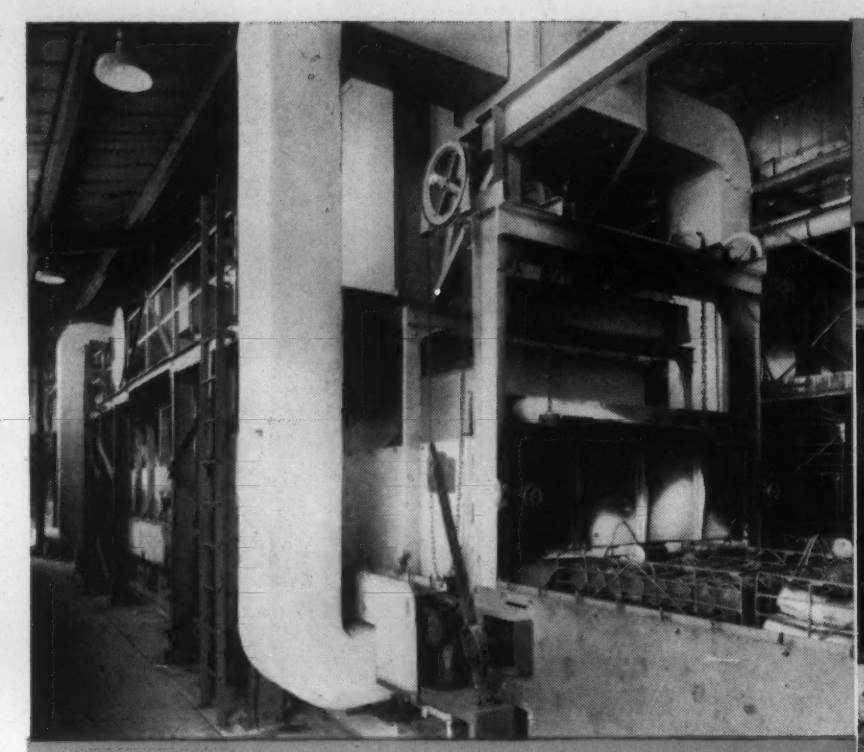
WEATHERING CHARACTERISTICS: Dowmetal possesses excellent stability in all ordinary atmospheres, with a proved record of successful performance under the extreme conditions of world-wide war, over a period of years. Since it is difficult to control the location and service conditions to which a product will be exposed, it is usually a good rule to apply protective paint systems. Chemical treatment and paint coating combinations have been developed which effectively protect Dowmetal against marine atmospheres. (See Table, left.)

THERMAL PROPERTIES: The coefficient of thermal expansion for Dowmetal Magnesium Alloys averages 0.000016 per degree F. When products subject to appreciable temperature changes are being designed, thermal expansion allowances should be made if Dowmetal members are rigidly connected to other metals. The mean specific heat of Dowmetal is 0.249.

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN

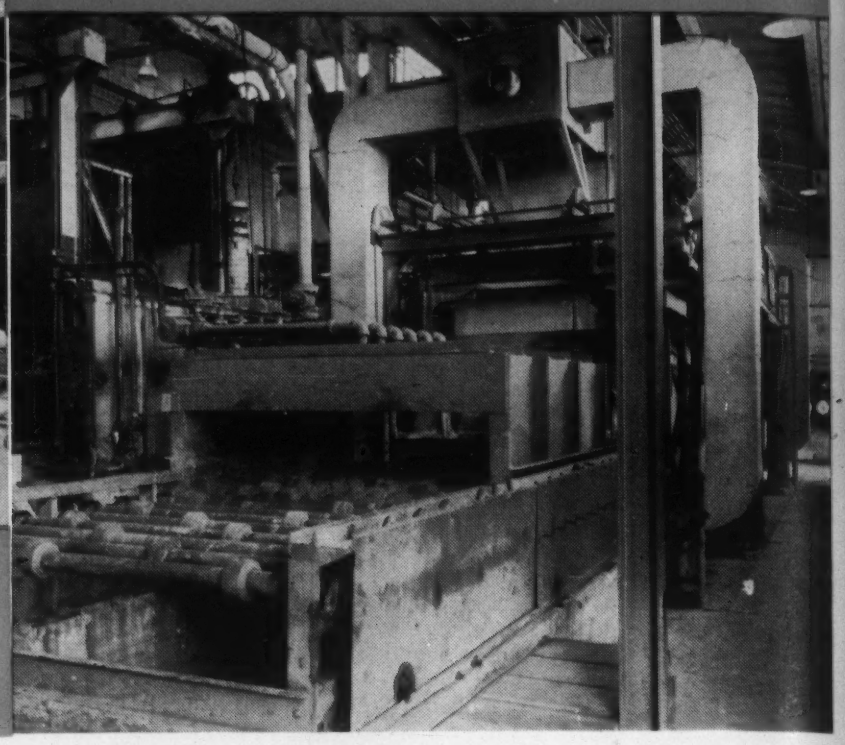
New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

FOR ADDITIONAL DATA, write for a copy of the new book, "DOWMETAL MAGNESIUM ALLOYS," or refer to Sweet's File for Product Designers.



DISCHARGE END—Spray quench located outside furnace discharge door to cool annealed material for unloading from roller table.

CHARGING END—Material in baskets on table ready to be charged into furnace for annealing cycle.



DREVER CONTINUOUS RECIRCULATING FURNACE for ANNEALING BRASS CARTRIDGE CASES

Another Drever continuous recirculating furnace . . . taking its place in an established production line where the flow of material ranges up to 10,000 lbs. per hour.

Units of this general type, with variable speed drive and large capacity gas or oil-fired air heaters, provide rapid heating for temperatures of 1250° or below, and are versatile, in that material can be conveyed through the furnace directly on the rolls or in special containers. All control and safety devices are incorporated.

We would be pleased to discuss with you the inherent advantages of Drever Continuous Furnaces which are designed in any required size to meet individual needs.

THE DREVER CO.

750 E. VENANGO ST., PHILA. 34, PENNA.

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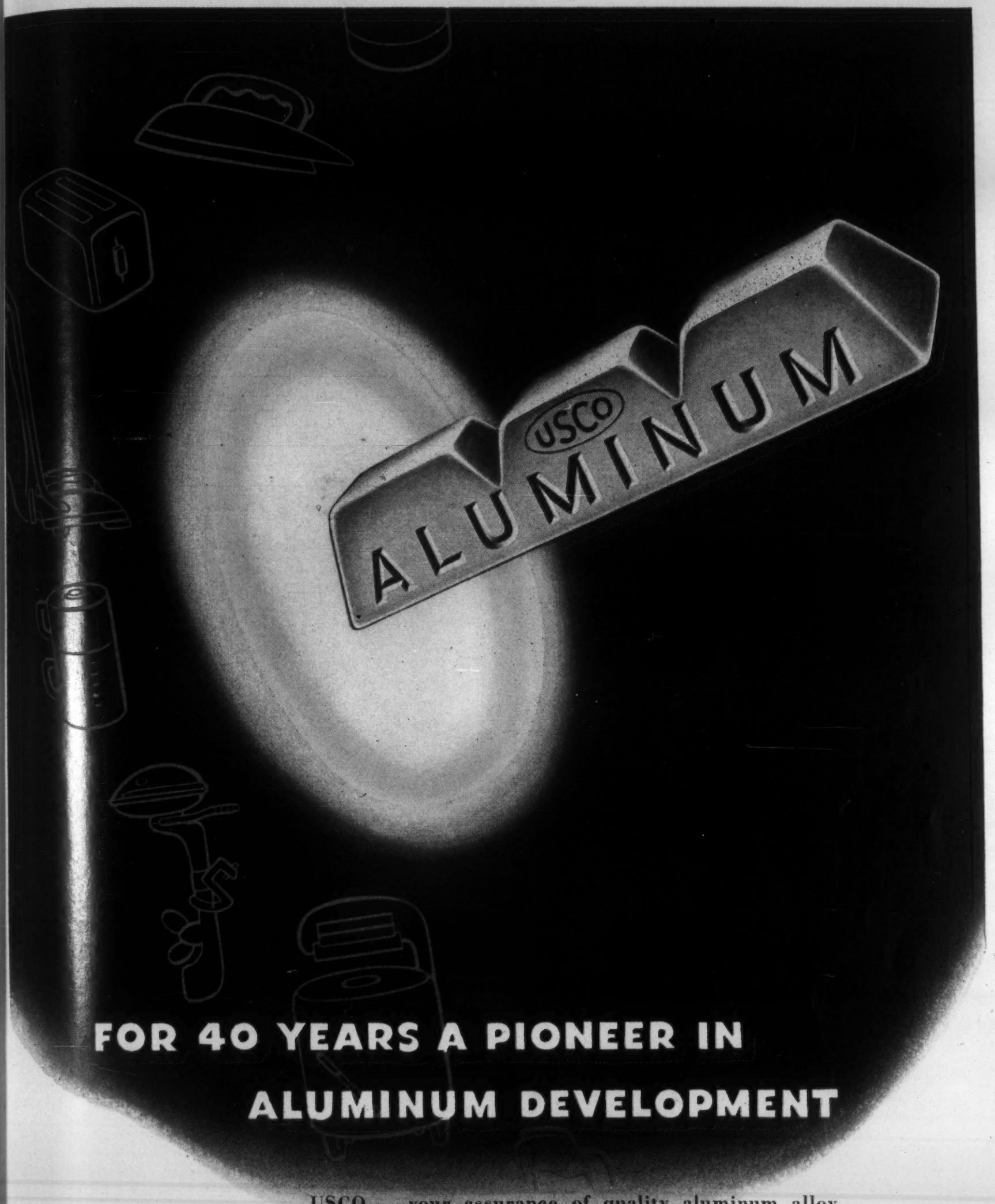

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USCO . . . your assurance of quality aluminum alloy ingot and deoxidizing shapes produced to exact specifications and backed by over 40 years of experience.

USCO

U.S. REDUCTION CO.

EAST CHICAGO, INDIANA

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THIS chunk actually contains only 2% **LITHIUM** — approximately ½ ounce. The other 98% consists of Cu, Zn, or bronze proportioned to match your melt. Yet this small quantity of **LITHIUM** is sufficient to remove gases, oxides, sulphides and other non-metallic impurities from a 200 pound melt of copper or bronze.*

LITHIUM works because it combines with these impurities forming non-metallic compounds of low specific gravity, insoluble in the melt and having a melting point below the casting temperature of the metal. These compounds volatilize, or flux out quickly, thus increasing the fluidity which often permits lowering pouring temperature. As a result, your castings are clean and sound, possessing optimum physical characteristics.

LITHIUM treatment requires no new technique, no new equipment, no special training for your crew. Our technical staff and our own casting facilities can be placed at your disposal.

*Tin bronze or silicon bronze.

LITHALOYS CORPORATION

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HIGH CARBON STRIP

COLD ROLLED SPRING STEEL

THE STRIP OF PRECISION STANDARDS

1. Accurate response to heat treatment
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3. Rigidly controlled chemical and physical properties
4. Exact constancy of grain structure
5. Record of performance in war-front products that assures a home-front preference

WRITE FOR A TEST SAMPLE

WEIRTON STEEL CO.

WEIRTON, WEST VIRGINIA *Sales Offices in Principal Cities*

SUBSIDIARY OF NATIONAL STEEL CORPORATION, GRANT BUILDING, PITTSBURGH, PA.

"WITH **Gulf Cut-Aid**

WE INCREASED PRODUCTION ON THIS MILLER 10%

———TOOL LIFE 50%

—says this Superintendent

(Left) Close-up of straddle milling operation on fins for impellers of geared aircraft superchargers. Tolerance on the sides of the fins is critical as to finish and dimensions. (Right) Actual photo of a Gulf Service Engineer consulting with Superintendent on results secured with Gulf Cut-Aid on this precision machining job.

GULF CUT-AID PROVED SUPERIOR to 12 other brands of cutting oil we tested for straddle milling aluminum alloy supercharger impellers," says this Superintendent. "With this revolutionary new cutting oil, we get 10% greater production and 50% longer tool life than with the cutting fluid we used previously."

This is one of hundreds of war plants that have increased production and tool life on precision work by using the proper Gulf Cutting Oil for each particular job requirement.

Gulf performance-proven cutting oils have established records on the toughest steels and most punishing schedules that the armament and aircraft industries offer. You'll find them helpful in improving production and tool life now and in paring costs below competitive levels in the postwar period.

Let a Gulf Service Engineer show you why Gulf Cutting Oils are ideal for many of your machining jobs. Write, wire, or phone your nearest Gulf office today.

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Advertisement DECEMBER, 1944

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

Non-Ferrous Hot Forgings Versus Castings For Better Engineering Properties

The tremendous strides made in engineering, so necessary for successfully conducting modern warfare, will be reflected in the production of better peacetime products in the postwar period. Today, engineers are more conscious of material specifications. They are concerned not only with the composition of the material or alloy used but also with its physical condition...whether in the form of a casting, stamping, cold forging, or hot forging. It follows, therefore, that engineers favor hot forgings over castings because of their superior engineering properties.

Forgings have a much higher tensile and yield strength than castings because of their refined microstructure and freedom from porosity. Furthermore, they can be held to uniform, precise dimensions and close tolerances—requiring less machining. Perhaps the most important advantage of forgings over castings is the fact that there are fewer rejections after final inspection and lower finishing costs, which insure economy of manufacture plus dependability. Forgings, therefore, are specified where service requirements are very severe and exacting, as for example: safety devices, pressure fittings and other parts which must not fail from fatigue or hidden weaknesses.

Non-ferrous forgings, because they do not deteriorate from rusting, are superior to ferrous forgings which must be treated by galvanizing or by the application of some other surface finish to retard corrosion from moisture and the elements. The range of non-ferrous forging alloys available makes possible a large variety of physical properties such as high tensile and yield strength, easy machinability, high impact strength; also, good sound surfaces which will take an attractive, lasting finish and pleasing colors.

Non-ferrous forgings are not necessarily weaker than ferrous forgings. For example, a mild steel forging has a tensile strength of approximately 60,000 pounds per square inch, which is similar to that of Naval Brass. An alloy like DURONZE III, whose tensile strength as a forging is between 85,000 and 90,000 pounds per square inch, is about 50% stronger than mild steel. DURONZE III is excellent for the manufacture of gears, pinions, thrust screws, sliding parts, and similar items because of its generally low coefficient of friction when in moving contact with steel or other metals. Maintenance men have found that wear and tear on heavy duty machinery can be reduced considerably by replacing many steel parts with DURONZE III. Forged Valve Stems from DURONZE III outlast steel and brass because of reduced wear and greater strength and corrosion resistance.

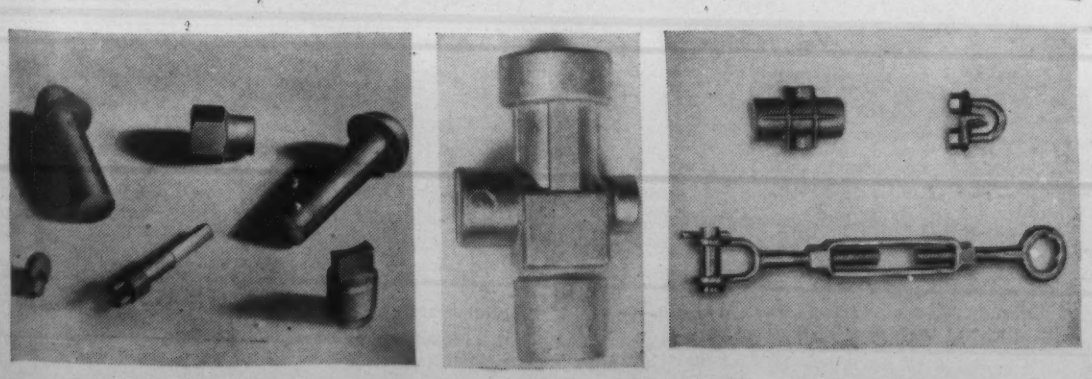
The mechanical and physical properties of six Bridgeport Brass forging alloys are shown in tabular form herewith. These data should be filed away for future reference. Reprints of this issue and most of the back issues of the COPPER ALLOY BULLETIN will be supplied upon request.

NON-FERROUS RODS FOR HOT FORGING

	Duronze III	Duronze II	Bpt. Forging Rod	Naval Brass	Manganese Bronze	Muntz Metal
ANALYSIS						
Copper %	91.0	97.03	59.50	60.0	58.5	59.75
Lead %		2.85 Silicon	1.75	.15		
Tin %		0.12 Iron	.20	.75	0.75	
Zinc %			38.55	39.1	39.45	40.25
Iron %	7 Aluminum				1.0	
Manganese %	2 Silicon				.3	
MECH. PROP. AS HOT FORGED (Average Values)						
Tensile Strength, psi.	90,000	55,000	55,000	60,000	68,000	56,000
Yield Strength, psi. .5% Ext.	45,000	24,000	20,000	24,000	30,000	21,000
Elongation, % in 2"	30	35	35	30	30	35
Rockwell Hardness	B85	B65	B50	B58	B67	B50
PHYSICAL CONSTANTS						
Melting Point (Liquidus) °F	1,810	1,895	1,640	1,650	1,630	1,660
Density, Lb./cu. in.	.278	.309	.305	.304	.302	.303
Coeff. of Thermal Expansion per °F from 77°F to 572°F x 10^{-6}	9.2	9.3	11.5	11.8	11.8	11.6
Thermal Conductivity Btu/sq.ft/ft/hr—°F@ 68°F	22	20	69	67	61	71
Elec. Cond. %IACS@ 68°F Soft	7	7	27	26	24	28
Mod. of Elas. (Tension), psi.	16,500,000	15,000,000	14,000,000	15,000,000	14,000,000	14,000,000
FABRICATION PROPERTIES						
Machinability Rating**	60-70	30	80	30	30	40
Cold Working	P	E	F	F	P	F
Hot Working	E	E	E	E	E	E
Hot Working Range °F	1300 1600	1350 1550	1200 1500	1200 1500	1150 1300	1150 1450
SPECIFICATIONS						
A.S.T.M.	B124-42T Alloy 11	B124-42T Alloy 9	B124-42T Alloy 2	B124-42T Alloy 3	B124-42T Alloy 4	B124-42T Alloy 1
Federal	QQB666 Grade B	QQC-591a Grade A	QQB-611A Comp. A	QQB-636	QQB-721a Class A	
Navy	46B17 INT Gr. 3	46B-27	47B-2g	46B-6J	46B-15d	
Army						
AMS	4631					

E—Excellent G—Good P—Poor F—Fair

**Machinability Rating—Free cutting brass=100.



The great variety of non-ferrous forging alloys available makes possible the manufacture of forgings with an unusually wide range of physical and corrosion resistant properties.

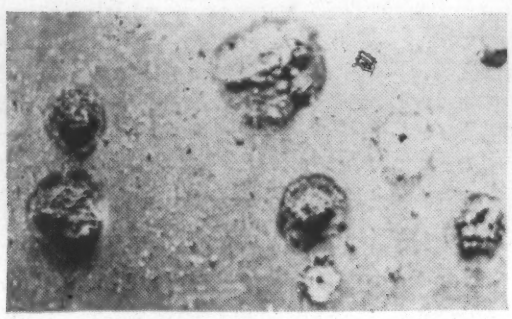
CAUSES OF CORROSION

This article is one of a series of discussions by C. L. Bulow, research chemist of the Bridgeport Brass Company.

Accelerated Corrosion— Hot Wall Effect

It is 20 years since Carl Benedicks carefully investigated a service failure encountered in steel boiler tubes. His work revealed that severe local corrosion or pitting can rapidly perforate heater tubes on the water side. The pitting takes place where bubbles of air separate from the water. He found that hot spots form on the heated tube surface at the points where the bubbles of gas cling to the metal.

Bubbles of gas repeatedly formed at the same point (usually at scratches or sharp indentations), thereby hindering the liquid from cooling the metal surface. It was also learned that the rate of perforation of a heater tube increased considerably with an increase in tube wall temperature.

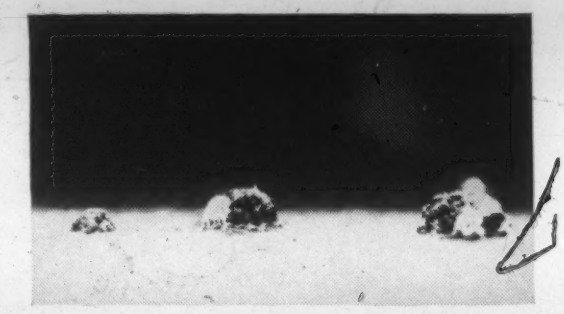


Nodules covering pits formed on the water side of a copper water heater tube. Mag. 8x.

This work suggested the following preventive measures:

1. The temperature should be no higher than necessary.
2. Continued uninterrupted heating should be avoided.
3. The production of new scratches on the metal surface might shift the point of bubble formation.
4. Air or gas should be removed from the liquid being heated.

Visual examination in the laboratory tests revealed that there is a marked tendency for the bubbles of gas to grow rapidly at first and then remain in contact with the metal tube for some time. In the laboratory tests, non-ferrous and ferrous tubes failed quite rapidly when exposed to 3% sodium chloride solutions. In service, such failures are occasionally encountered on the liquid or water side which may be either the inside or the outside of the tube. Water heaters and evaporators with steam



Side view of nodules covering pits formed on the water side of a copper heater tube. Mag. 8x.

or flame on one side of the tubes illustrate the most common equipment where pitting occurs because of the "hot wall effect".

In ferrous tubes, (18-8 stainless steel) deep circular pits formed on the under side of horizontal tubes, where the bubbles pressed against them. The final rolling of the gas bubbles up around the side of the tube produced a noticeable upward streaming of the rust; localized corrosion was virtually absent on the top side of the tube. The pitted areas were covered with small grayish colored deposits resembling fish scales and a thin film of red brown rust covered the remainder of the unattacked or slightly attacked surface.

The copper base alloys behaved similarly to the stainless steel except that nodules of black or greenish black corrosion products (essentially Cupric Oxide, CuO) formed over deep pits which were filled with bright red, crystalline cuprous oxide (Cu_2O). This localized corrosive action proceeds at rates from 0.025" per year or more.

Apparently, there are several important factors which are accelerating the corrosion at the point of bubble contact, namely the combined action of:

1. A local high temperature...
2. A high concentration of corrosive agents (base or salt), separating out where the bubble forms...
3. Quantity of dissolved gases.

In addition, the gas composition of the bubbles also probably plays a part. It should be noted that the reaction between the corrosive agent and the metal is a chemical one, yet the explanation given places the emphasis upon the physical aspect, which makes possible this rapid corrosive action.

NEW DEVELOPMENTS

This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for information.

A New Jack Welding Control is now available in 150 and 230 ampere sizes. It has a special tack welding circuit control panel designed for tack welding with constant potential supply. Round nichrome wire resistors are mounted on insulators and the housing has sheet metal sides with an expanded metal top to provide full circulation of air. Current values are controlled by contacts and are adjusted by turning fibre handles tight against copper bus bar to connect various resistors into circuit. Resistors are disconnected by turning handles in opposite direction and locking them in position. Current adjustment in both units is possible in 10-ampere steps. (582)

A Blind Fastener serving as nut-plate, rivet or both, is now being made of brass as well as aluminum. The tensile and shear strength of the brass alloy fastener is approximately 50% greater than that of equivalent size in aluminum. These devices are being employed for many industrial assemblies in addition to aircraft applications for which they were originally designed. (583)

A New Fire Extinguisher that is highly adaptable for use on trucks, automobiles, boats and planes is now available. It is light in weight and employs a vaporizing liquid that may be used effectively on electrical, oil and gasoline fires. The design assures immediate piston action even after long periods of disuse. Piston cannot stick to cylinder wall and a panic safety lock is operable by turning the handle in either direction. Brass drop forgings are used for cap, stuffing box, handle lock and handle seal, eliminating all interior soldered joints. It will not leak, even when subjected to vibration or rough handling. (584)

A New Welding Ground Clamp has been developed with each jaw connecting independently to the ground cable. The welding ground clamp assures proper ground connection with either one or both jaws carrying rated current. The unit weighs 1½ pounds, has a maximum jaw spread of 2½ inches and is rated at 300 amperes. The clamp has a processed steel frame with durable copper conductors and contacts. (585)

PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

Executive Offices: BRIDGEPORT 2, CONN.—Branch Offices and Warehouses in Principal Cities

SHEETS, ROLLS, STRIPS—*Brass, bronze, copper, Duronze,* for stamping, deep drawing, forming and spinning.

CONDENSER, HEAT EXCHANGER, SUGAR TUBES—For steam surface condensers, heat exchangers, oil refineries, and process industries.

PHONO-ELECTRIC* ALLOYS—High-strength bronze trolley, messenger wire and cable.

WELDING ROD—For repairing cast iron and steel, fabricating silicon bronze tanks.

LEDRITE* ROD—For making automatic screw machine products.

BRASS "Bridgeport" CO.

Established 1865

BRASS, BRONZE, DURONZE WIRE—For cap and machine screws, wood screws, rivets, bolts, nuts.

DURONZE ALLOYS—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware: *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

COPPER WATER TUBE.

FABRICATING SERVICE DEPT.—Engineering staff.

BRASS AND COPPER PIPE

Note: Bridgeport products are supplied in accordance with existing priority regulations.

*Trade name.

BRIDGEPORT ARMY E NAVY **BRASS**

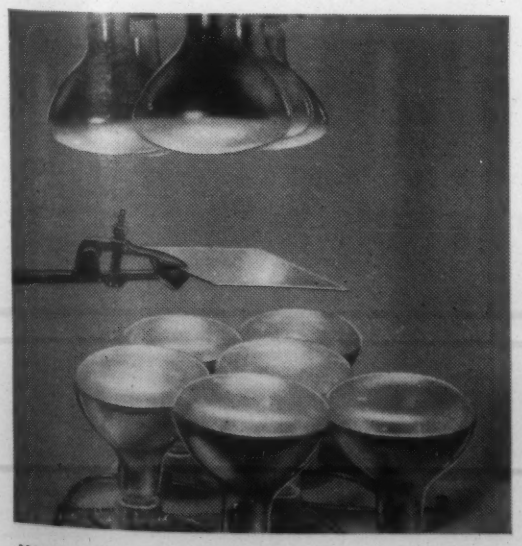
check this new development for '44 . . . form

INTRICATE SHAPES FROM FLAT SHEETS WITH MICARTA "444"

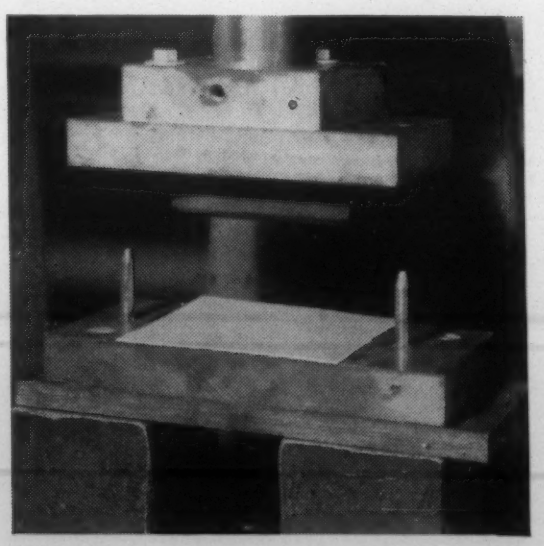
Micarta "444"—a new development in manufacture—now offers a new, practical and economical means for forming structural shapes from completely cured flat sheets . . . with low-cost equipment, and dies of non-critical materials. Shapes like those shown can be produced easily and quickly—in most cases with inexpensive wood molds and by use of a simple arbor press. Deep draws, sharp bends and intricate shapes may be obtained. Parts produced are strong, stable and permanent.

Originally developed for aircraft needs, Micarta "444" is being used for trim tab fairing, fuselage tail-wheel housings, ammunition feed chutes, and for many other practical applications. It provides characteristic Micarta properties of strength with lightness, and resistance to heat, cold, humidity and chemicals. Investigate the full story—write for the new Micarta Data Book B-3184-A. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. J-06349

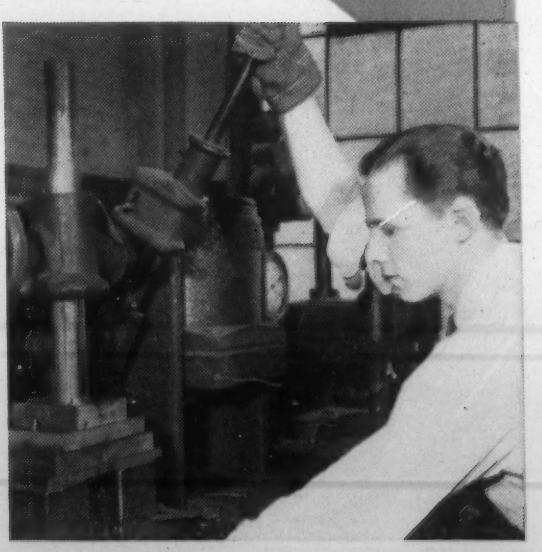
Westinghouse
Micarta
THE INDUSTRIAL PLASTIC



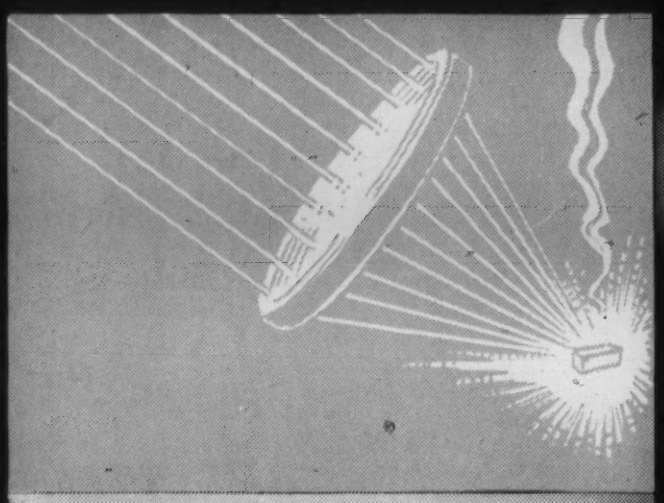
JUST HEAT . . . Premolded and cured flat sheets are heated uniformly on both sides by infrared lamps, ovens or parallel hot plates to just under the blistering point.

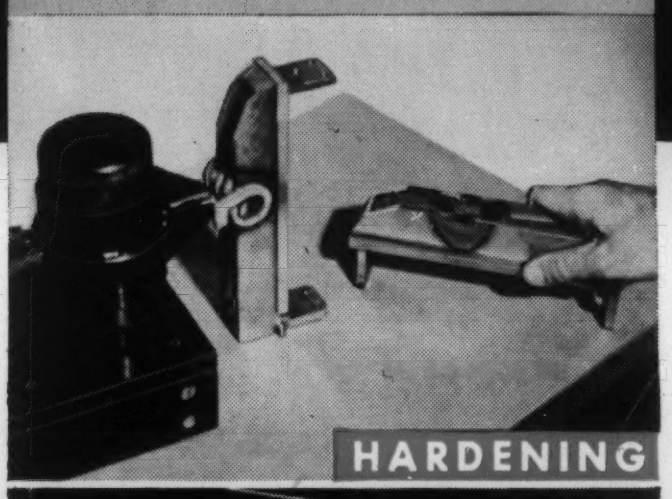


INSERT . . . Heated sheet is then placed in inexpensive wood mold in arbor press or where pressure can be applied to molds.



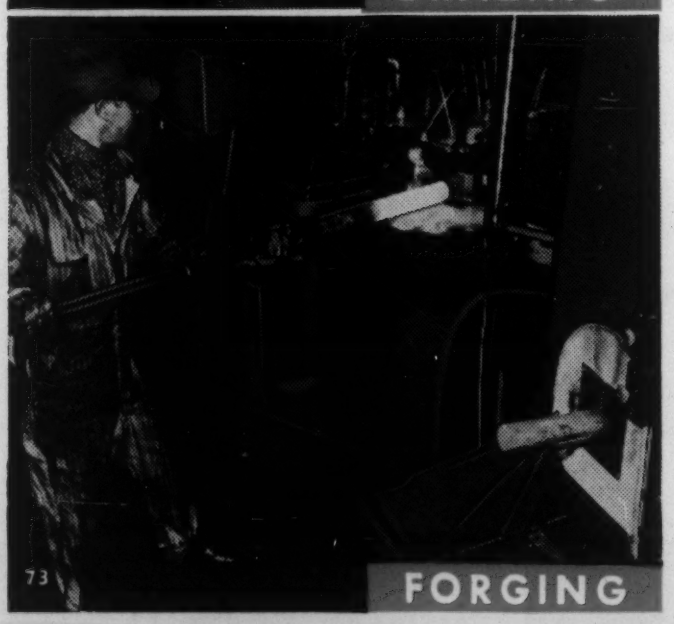
AND FORM . . . Pressure at approximately 100 pounds per square inch is applied, and shape left to cool briefly in mold. Resulting shape is permanent.



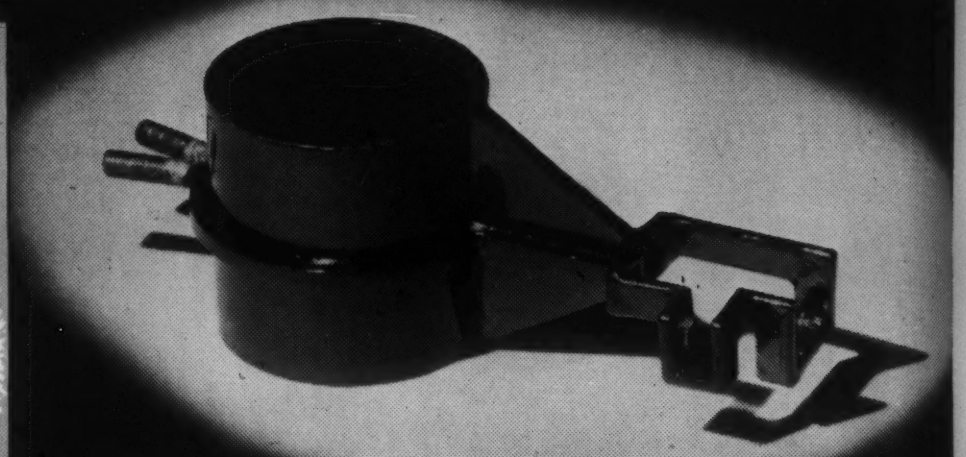


HARDENING

BRAZING



FORGING



Focused Heat

with AJAX-NORTHRUP

The little coil pictured above focuses 6 kilowatts of high-frequency current into a small complicated joint, and produces perfectly brazed bourdon gauge parts at an amazing rate of speed — at low unit heating cost, with no distortion and no clean-up required.

Aptly named a focus inductor, the coil was designed by Ajax-Northrup engineers to control and accurately concentrate the heat — no need to heat the whole part just to braze one small joint.

This particular coil may not fit your work, but suitable inductors or furnaces can be designed to do your production heating jobs with higher speed and quality. By simply changing inexpensive coils and jigs, you can do several operations with the same Ajax-Northrup equipment.

AJAX-NORTHRUP *Engineering*

For over a quarter of a century Ajax-Northrup engineers have successfully solved hundreds of heating problems with focused high-frequency heat.

We may already have solved problems similar to yours. Call on the full weight of our experience to help you revolutionize your production heating and melting for war now and for peace later.

AJAX-NORTHRUP

HIGH-FREQUENCY MELTING HEATING

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